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GALLSTONE DISEASE.[1]

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While, of late years, much consideration has been given to the subject of gallstone disease, and while many brilliant cures have been brought about by the proper application of surgical methods, the last word on the subject has yet to be written, and there are many moot points of equal interest to the internist and the surgeon that impress me with the importance of further discussion of disease of the biliary tract. By reason of its function as the excretory apparatus of the largest gland in the body, by reason of its intimate relations with vital organs in the upper abdomen, and by reason of its liability to infection and its commanding position to spread infection over a greater or less extent of the peritoneal cavity, the biliary apparatus may justly be considered unique.

To many surgeons the biliary apparatus consists, surgically speaking, of the hepatic ducts, the gall-bladder, the cystic duct, and the common duct; but studies in the pathology of the living have impressed me with the importance of considering the extent of the biliary tract from its developmental standpoint. Thus, every secreting cell in the liver is surrounded on one or more sides by a bile capillary; these capillaries unite to form bile vessels situated between the lobules of the liver; the bile vessels, increasing in size, unite with one another until eventually the large common hepatic duct is formed, and this, uniting with the cystic duct from the gall-

[1] Read at the Forty-first Annual Meeting of the Canadian Medical Association, Ottawa, June 11, 1908.

bladder, forms the common bile duct. But not only developmentally, but also clinically, the biliary tract does not end here. Embryologically the pancreas with its main duct and intermediate tubules is derived from the outgrowth of the biliary tract from the duodenum, and clinically this abdominal salivary gland is frequently secondarily involved in gallstone disease. Hence, considered in this wise, there is a very extensive area comprising countless square inches, which, like the mucous membrane of the respiratory and the urinary systems, affords a broad and fertile field for the implantation and unlimited spread of infection.

The common infectious agents of the biliary tract, in order of their frequency, are: Bacillus coli communis, Bacillus typhosus, and the common pyogenic organisms. How do these bodies invade the biliary tract? The three ordinary pathways are the portal circulation, the common bile duct, and the systemic circulation.

What is the immediate result of infection of the biliary tract? "As in other mucous canals . . . . the production of a catarrh, with the usual inflammatory phenomena—œdema and congestion of the mucous membrane, increased production of mucus, and desqumation of epithelium. If the biliary circulation is free and unimpeded the results of this catarrh are washed away for the most part, but on account of special local conditions (largely dynamic) they are likely to accumulate, to become accentuated, and to persist in the gall-bladder. In the event of obstruction to the free flow of bile these are the more certain to occur. In many cases the lesions thus provoked are entirely latent or unannounced by noteworthy or unequivocal symptoms; they may pursue a short course, or they may continue for years; and they are one of the most important factors, in fact the important factor, in the etiology of gallstones.

"This infection of the biliary tract is of the utmost significance, and forms an integral part of what is commonly designated calculous cholecystitis and cholangitis. The phenomena may develop: (1) Acutely, without preceding clinical signs referable to the gall-bladder; (2) subacutely; and (3) chronically. The ensuing pathological lesions are of the greatest diversity: Thus, for instance, gallstones may or may not be present, and the concomitant inflammatory phenomena may be of varying grades—from the mildest catarrhal lesions to widespread phlegmonous and ulcerative processes that may lead to perforation or gangrene of the gall-bladder; gallstones, if present, may be quiescent or active; they may be present in the gall-bladder, or in any one of the ducts, or in all the ducts, or in the ducts and not in the gall-bladder; they may cause an acute or chronic, partial or complete, temporary or permanent, obstruction of the cystic, the hepatic, or the common bile ducts, and, on the other hand, such obstruction may occur in the absence of gallstones (being due to swelling of the mucous membrane, kinking of the ducts, or obstruction from without), and in the presence of gallstones the ducts

may be partially or completely patulous; the gall-bladder may be distended or contracted, its walls thinned or much thickened, and its lumen ultimately may become almost if not quite obliterated; it may contain bile, mucus, blood, or pus, or combinations of these, in addition to or in the absence of gallstones; adhesions may form between the gall-bladder and adjacent structures (the liver, the stomach, the duodenum, the colon, the omentum, etc.), and by way of the adhesions the gallstones may rupture into the gastro-intestinal tract and sometimes cause intestinal obstruction; or purulent pericholecystitis and pericholangitis, localized or generalized peritonitis, pylephlebitis, pericholangitic abscesses of the liver, fistulæ, acute and chronic pancreatitis, etc., may ensue; and, finally, in some cases a general bacterial, often pyococcic, infection, with or without multiple abscess, may develop."[2] Furthermore, the long-continued infection may seriously involve the arterial and urinary systems, producing such degeneration of the myocardium and kidneys that often makes the surgeon loath to operate.

Cholecystitis may be calculous or non-calculous. The larger one's experience in gallstone disease the less able is he to state whether gallstones are, or are not, associated with cholecystitis. Cholecystitis is caused by invasion of the fertile mucous membrane of the gall-bladder by pathogenic bacteria. This event brings about the classical symptoms of inflammation. Pain is situated in the epigastric region, is usually sharp, appears suddenly or gradually, and is increased by motion either of the entire body or of regional organs, such as the stomach in peristalsis or in vomiting. The accompanying tenderness indicates the situation of the gall-bladder in the absence of peritonitis; the presence and extent of peritoneal irritation or peritonitis is indicated by the extent of the associated tenderness. The swelling of the mucous membrane occludes the cystic duct, and thus isolates the gall-bladder from the intestine. By loss of function the gall-bladder, instead of being the reservoir for bile, now becomes the repository of pathological exudates. This causes distention of the organ, and thus the tumor may, in favorable cases, be palpated. In the case of the gall-bladder, loss of function bears much significance, as the products of inflammation may lead to the formation of gallstones.

The severity of the cholecystitis is indicated by the general symptions, and varies with the virulence of the infection; for example the simple pathological processes of œdema and congestion of the mucous membrane, increased production of mucus, and desquamation of epithelium unite to form the clinical entity of acute catarrhal cholecystitis. This entity makes itself known to the outside world by the general symptoms of fever with its accompanying

[2] A. O. J. Kelly: Infections of the Biliary Tract. Amer. Jour. Med. Sci., 1906, cxxxii, 446.

phenomena of chill, accelerated pulse, vomiting, dry and coated tongue, scanty high-colored urine, and leukocytosis. Locally, there is pain, tenderness, and rigidity. Such a mild case I consider appropriate for judicious medical treatment, for if the biliary circulation is free and unimpeded the results of this catarrh are washed away for the most part. If this mild cholecystitis yields promptly to medical treatment, and the patient is having his first attack, I think operation may well be postponed until further symptoms arise. Calculi are probably absent in such mild cases in early attacks, and such patients seem to me particularly suited for the so-called Carlsbad cure. When the attacks of cholecystitis are repeated, and especially when discomfort persists in the intervals, operation is demanded to obtain a cure. The frequency with which mild but recurrent attacks of cholecystitis give rise to pericystic and pyloric adhesions, I fear, is not duly appreciated by all of the profession.

But suppose the medical attendant does not see the mild case clear up, that the symptoms become more severe: what is going on in the gall-bladder? There is obstruction to the free flow of bile, and as Dr. Kelly says because of special local conditions (largely dynamic) the results of the catarrh accumulate, become accentuated, and accumulate in the gall-bladder. Here the infection is more virulent, and the pathological changes have now produced the clinical entity of acute purulent cholecystitis, or empyema, a condition which I found in 16.4 per cent. of a series of 182 cases recently operated upon. The fever now becomes hectic in type, and the brow is bathed in sweat; there may be delirium of the low, muttering type. Local pain, tenderness, and rigidity, are increased. The patient loses flesh, his appetite is poor, and he frequently asks for water to drink. Here medical means are futile, but a cure is usually effected by cholecystostomy, during which procedure any obstruction that may be found in the cystic duct should be removed. Empyema requires cholescystectomy only when of long standing, such chronicity resulting in irreparable disease of the walls of the gall-bladder.

If the infection be very virulent, the walls of the gall-bladder will become infiltrated by the products of phlegmonous inflammation, which may undermine the mucous membrane, interfere with the blood supply of the organ, and lead to gangrene. Other varieties of acute cholecystitis, of pathological interest, are the hemorrhagic and the ulcerative. The hemorrhagic form is made manifest, when, upon opening the gall-bladder, blood clots are found. In this instance microscopic ulcerations are active in opening into congested veins, and it is possible that, for a time, at least, the bleeding is furthered by the local anti-clotting action of the bile, an action that, to the annoyance of the surgeon, is most manifest in that state known as cholemia. Ulcerative cholecystitis becomes of interest clinically when it results in perforation of the gall-bladder. Gangrene of the gall-bladder naturally requires excision of the gall-bladder, and also does per-

foration, since it occurs most frequently when the gall-bladder walls are extensively diseased.

If unchecked by surgical means the infection may spread from the gall-bladder through the cystic and hepatic ducts into the interlobular bile vessels, and even into the intercellular bile capillaries. Such a pathological extension creates the clinical entity of infective cholangitis, the symptoms of which are manifested by ague-like attacks, to which Charcot has applied the term of intermittent hepatic fever. To the previous symptoms of cholecystitis there is now added the sign jaundice, which may be of the intermittent type. But it must be remembered that infectious cholangitis often follows upon the impaction of a calculus in the common bile duct. The treatment of this condition is to see that the entire biliary tract is clear and unobstructed, and to secure free drainage.

If unrelieved acute infectious cholangitis may be the forerunner of suppurative cholangitis. Suppurative cholangitis may also arise from acute infectious disease, especially typhoid fever and influenza, from carcinoma of the bile ducts, and from hydatid disease. Symptoms of septic fever, rapid loss of flesh, and obstinate jaundice now supervene. The treatment is that of infectious cholangitis, namely, bile drainage.

Acute purulent hepatitis is the terminal condition of this triumphal march of bacteria from the gall-bladder to the liver. In this organ, wrecked by infection, the last stand of the organism is made: multiple hepatic abscesses form, and the patient finally succumbs from the uncontrollable fever and toxemia. It is in such cases that operation retards the progress of modern surgery. If the infection be less virulent, biliary cirrhosis of the liver, usually the result of gallstone blockage, may ensue. In the presence of this latter entity, clearance and drainage of the biliary tract may relieve the patient by depleting the liver, but it cannot remove the adventitious fibrous hypertrophy.

Having traced infection of the biliary tract by continuity let me trace it by contiguity. It is here that a gall-bladder, its walls permeated by phlegmonous infiltration, becomes a paramount source of danger by reason of its commanding position to spread infection over a greater or less extent of the peritoneal cavity, a circumstance to which attention was directed in the early part of this paper. The virulent bacteria may pass directly through the gall-bladder walls, or give rise to ulceration or perforation, and then quickly involve the neighboring peritoneum. If the peritoneum be alert, pericholecystic abscess may ensue, with marked tenderness and rigidity; a correct diagnosis of this condition should lead to immediate evacuation. In neglected cases the pus, like water, follows in the direction of least resistance, and this may lead it into the peritoneal cavity, the ailmentary tube, the subhepatic retroperitoneal tissue, or, if it accumulate between the superior surface of the liver and the right cupola of the diaphragm, it may creep through this into the right pleural

sac and the lung, to be spat up by the patient. Much more commonly than this, however (in 58.7 per cent. of 182 cases recently reported by me), the diffusion of the toxins in the regional peritoneum in small repeated doses, evokes patches of fibrinoplastic exudate, which reach out octopus-like for nearby organs, and, by subsequent contraction, throttle more or less completely those that are hollow, as the stomach, duodenum, or colon, thus increasing the complaint of the patient and the operative difficulty of the surgeon. The omentum, the organ of phagocytosis, may complete the Gordian knot by fettering the already shackled tissues to the liver; the frequency with which such masses are mistaken for malignant disease is attested by operators. However, until this tangle of tissue is established, the patient's life probably hangs in the balance, for such a mass of adhesions may represent the only alternative to diffuse purulent peritonitis.

A gall-bladder once damaged by infection may, if the infection be mild, undergo complete resolution. Repeated mild attacks of inflammation, or a severe and extensive infection may determine chronic cholecystitis. Interference with the physiological periodic expulsion of bile from the gall-bladder—a condition brought about by permanent obstruction of the cystic duct from chronic inflammatory changes, or by a stone—results in absorption of the bile contained therein at the time of blockage, and its replacement by clear, watery mucus. Thus hydrops of the gall-bladder occurd in 7.1 per cent. of 182 cases recently reported by me. This condition is one of the few that calls for cholecystectomy, since obliteration of the cystic duct renders the gall-bladder not only useless, but also a continued menace from the liability to reinfection or even of rupture. The only exception I would make to this rule is obstruction of the cystic duct by stone, if recent; if the gall-bladder show but little macroscopic evidence of disease, and if after dislodgement of the stone bile flows immediately into the gall-bladder, it may be wise to leave the organ. Destructive bacterial invasion of the walls of the gall-bladder is followed by the ultimately destructive effects of constructive repair, resulting in abolition of the normal suppleness of this little bile-containing bulb. Contraction, that inevitable consequence of fibrous degeneration, gradually obliterates the cavity of the gall-bladder, and the surgeon sees frequent instances in which this has been accomplished. What space may remain in such an organ is usually filled with ropy, tarry, inspissated, and pathologically altered bile. Such shriveled gall-bladders should be drained or removed, in keeping with the possibilites of the case and the judgment of the operator.

In order to emphasize these remarks by practical illustrations, I have analyzed the 72 cases of gallstone disease operated upon by me during the twelve months ending with April 1, 1908.[3] Of the

[3] For a larger list of 217 cases previously operated upon by me, see AMER. JOUR. MED. SCI., 1908, cxxxv, 137.

72 cases, 9 were examples of chronic, non-calculous cholecystitis, with no mortality; whilst of the remaining 63 cases of cholelithiasis, 4 were fatal.

Glancing over the histories of the 9 sufferers from non-calculous cholecystitis, I am impressed with the constancy of symptoms of dyspepsia, and the presence of adhesions. Thus, 7 of the 9 complained of such discomfort after eating, as oppression in the stomach, burning, and eructations of gas. And in 8 of the 9 cases adhesions were found, usually between the gall-bladder and some part of the alimentary tube, as the stomach, the duodenum, or transverse colon, or between the gall-bladder and omentum. These adhesions are relics of bygone infection, and make dyspeptics of their bearers. That the infection, as a rule, had long since departed was shown by positive cultures being obtained from only 2 of the 9 cases, while in 2 others there were no bacteria, but lymph nodes were enlarged, in one case along the cystic, and in another along the common duct. Furthermore these patients were subject to frequent attacks which increased in number with the duration of the disease. Such attacks usually followed dietary indiscretions, and started with pain in the right hypochondrum, radiating to the back and right shoulder blade, with nausea and vomiting, sometimes chills and fever, and sometimes followed by jaundice. Some patients complained of continuous tenderness over the gall-bladder, frequently aggravated by exercise —further evidences of the baneful effect of adhesions. The gall-bladders were usually atrophied, with walls thickened sometimes to as much as one-quarter of an inch. One patient had been operated upon two years previously, when 200 stones were removed from the gall-bladder. Within the past year he had three attacks of paroxysmal, crampy pain in the epigastrium, referred to the right scapula, preceded by chills and followed by gaseous eructations and vomiting. Operation revealed a greatly thickened gall-bladder, firmly adherent to the anterior abdominal wall. This gall-bladder was removed. Of the 9 cases I was able to save the gall-bladder in 6, which were merely drained; the remaining 3 were so badly diseased as to demand removal.

While cholecystitis in its various forms may be present without cholelithiasis, yet the two are so frequently wedded etiologically and pathologically that it is not strange that a differential diagnosis cannot always be made by clinical signs alone. The natural history of gallstones is interesting; their accurate diagnosis, satisfying; their removal, comforting.

Normal bile has been found contaminated with bacteria, but this is of little moment so long as there is no disease of the gall-bladder walls, and the biliary stream is unimpeded. Obstruction to the outflow of bile from this bulb, therefore, is the first step toward calculus formation, since whenever bacteria are bottled up they tend to create mischief, although now and then they die out.

Infection is the forerunner of inflammation; inflammation means cell proliferation, exudation, and altered function—a succession of events favorable to the precipitation of biliary salts. By means of mucin these salts are agglutinated, and with the cholesterin formed by degenerative changes in the epithelial cells, form calculi. At first the stones are soft, but, with time, become harder and harder. Recent soft calculi are preferred by bacteria to older, harder ones; for, whereas bacteria are continually present in the former, they are frequently absent from the latter. In a recent article on the etiology of cholelithiasis, Funke says: "While the almost constant presence of bacteria in recently formed calculi appears to indicate their presence in the bile at the time of the calculus formation, the experiments of Gilbert and Fournier and of Chauffard furnish sufficient ground to refute such conclusion. These investigators have succeeded in demonstrating secondary penetration of the calculi. They also succeeded in demonstrating that the organisms travel in the other direction. These observations may explain the frequency with which soft calculi are inhabited by organisms. The finding of sterile bile and infected calculi at the same operation can scarcely be held to controvert secondary penetration, for the bile may have become bacteria free after having infected the concretions. Although secondary penetration cannot be doubted in the light of the experiments quoted, yet there are few authors who hold that the presence of bacteria in the concretions must in all instances be regarded as such."

Without discussing further how gallstones become infected with bacteria, the fact remains that such bacterial hives argue ill for their bearer. Once formed, how long before gallstones produce wailing and gnashing of teeth? Richardson says: "During that more prolonged period of time between the first aggregation of the crystals which form the gallstone and the development of a gallstone large enough to obstruct the duct, a very considerable interval of time must elapse. Just how long that period of time may be is a matter of inference. Before they begin to offend, gallstones usually have a very considerable age. The age of a stone is judged not by its size, but by its consistency. A soft stone, easily crushed between the the fingers, of a light lemon color, I usually regard as a recent one. A dark, rough stone, especially if it is made up of different kinds of salts varying in color and in hardness, would probably be much older than a stone composed of salts of the same consistency and the same color."

I believe there is scarcely anyone with large experience in gall-bladder surgery who does not see examples of the different stages through which gallstones pass during their development, did he but recognize them as such. In discussing the pathology of cholecystitis, McFarland says: "Sometimes gall-bladders are found filled with inspissated bile, rich in bacteria, sometimes filled with bile containing

a pulpy mass, probably a precipitate of the bile salts about this bacteria mass; sometimes the entire contents of the organ will be pasty, mushy, gritty, or gravelly; sometimes a single stone and sometimes a large number of stones will be present."

From the above remarks I think I am justified in bringing up the question of the preventive treatment of cholelithiasis. This, however, seems premature at the present time, since the early symptoms of even fully matured gallstones are just beginning to be understood and are not always detected; the symptoms that may be interpreted as forerunners of those of fully formed calculi are even less known.

More significance, I think, must be attached to the contents of opened gall-bladders. When a surgeon drains a gall-bladder of the products of cholecystitis; when he empties it of inspissated bile rich in bacteria, or of bile containing a pulpy mass; or when he evacuates pasty, mushy, gritty, or gravelly material, is he, with his knowledge of the natural history of gallstones, not justified in believing that in each of these instances he has carried out the preventive treatment of cholelithiasis? When he removes stones, since these are found after an unknown, but probably long lapse of time, he is operating comparatively late in the disease. And when he must perform choledochotomy for calculi that have reached as far as the common duct, or when he drains a gall-bladder for chronic pancreatitis that has resulted from gallstone disease, or removes tissue made cancerous by the same cause, he may find consolation in the old saying, "Better late than never."

Gallstones lodged in the fundus of the gall-bladder may be likened to shot in the breech of a gun, and the biliary ducts to the barrel of the gun. If the gallstones remain quiescent, as is claimed for them in a certain percentage of cases, the gun is never discharged. If, on the other hand, infection or some other factor starts the gallstone or stones along the biliary tract, the gun is discharged and the explosion manifests itself in the colicky pains and other disturbances the patient experiences. The missile or gallstone may travel *per vias naturales*, and drop harmlessly out of the anus, or be vomited forth. Or, by ulcerating a passage for itself, it has the effect of a gunshot wound from a missile of extremely low velocity, and makes its way by fistulæ directly to the surface, or into the digestive tube, or elsewhere.

It is doubtful if gallstones can be present without producing symptoms, as is claimed for about 5 per cent. of gallstone subjects. We now know that it is not necessary for a diagnosis that the manifestations of gallstone disease be displayed on transparencies bearing, in large letters, the words "colic" and "jaundice." We look to the earlier writings of the disease, and attach due significance to the various expressions of "indigestion," as epigastric distress, anorexia, flatulence, eructations, heart burn, nausea, and vomiting. If there is not out-and-out pain, there may be, as Richardson says, a consciousness of discomfort in the epigastrium, in the right hypochondrium, or some-

times in the left—"a discomfort for which the patient seeks some simple remedy which she has in the past found efficacious—a hot water bottle, a liniment, an aromatic, a digestive, a carminative." In such cases pericholecystic adhesions or gallstones provoke these slight symptoms. Richardson writes: "One patient examined very recently, who has a gall-bladder filled by two large stones, says that she has never had any trouble, but she goes on to say: 'Of course I have to be very careful what I eat on account of these bilious attacks which I have been subject to for years.'" Thus, not only must the patient restrict his appetite, a matter which means mental suffering even for the healthy, but he must suffer the consequences of dread of eating, which, continued for a long time, brings loss of weight and strength, and consequent weakness.

Of the 72 patients with gallstone disease reviewed for this article, 63 had gallstones, and of these 4 died. The stones were distributed as follows: 44 times in the gall-bladder; 5 in the gall-bladder and cystic duct; 1 in the cystic duct alone; 3 in the gall-bladder and common duct; 1 in the gall-bladder and common and hepatic ducts; 1 in the cystic and common ducts; 4 in the common and hepatic ducts; and 4 in the common duct alone. For practical consideration we may divide the stone-bearing areas into two groups, placing in the first group all stones that were found between the fundus of the gall-bladder and the termination of the cystic duct; and, in the second, all stones found in the hepatic and common ducts. Of the 63 patients, 12 were males and 51 females. Most of the patients were between the ages of forty and sixty years. Nine patients had had enteric fever, but the typhoid bacillus was recovered from only 2, both of whom had experienced the disease within six months previous to operation. The typhoid bacillus was reported from cultures of 2 others, neither of whom had ever had enteric fever. The colon bacillus was found in 11, and Staphylococcus aureus in 3.

Of the 63 patients, the disease had existed one week or less in 8; one year or less in 21; from one to five years in 16; from six to ten years in 7; from eleven to twenty years in 6; from twenty-one to thirty years in 1; from thirty-one to forty years in 1; and the duration was not mentioned in 3. Chronic dyspepsia was the complaint of 32. The pain was sudden and sharp, or crampy or spasmodic, and located over the gall-bladder in 57, but dull and burning in 1. It was referred to the back in 6, to the right scapula in 28, and to both back and scapula in 9. There was tenderness over the gall-bladder in 44; over Robson's point in 9. Rigidity of the right rectus was present in 9 cases. Attacks came on at night in 16. Nausea was the complaint of 2; vomiting of 20; and both nausea and vomiting of 22. Chills were present in 10 cases; chills and fever in 4; chills, fever, and sweats in 14; chills and sweats in 1; and fever and sweats in 1. Jaundice was present alone in 27 cases; jaundice with clay-colored stools and biluria in 10; while but 2 complained of itching of

the skin from jaundice; 15 patients had lost from ten to sixty-five pounds in weight; 4 patients found stones in the stools. The liver was enlarged in 16. The gall-bladder was determined enlarged clinically in 6. The stomach extended down near or to the navel in 5. Carcinoma of the liver was seen once.

Adhesions were found as follows: around the gall-bladder in 4; around the common duct in 4; gall-bladder and stomach, 10; gall-bladder and liver, 1; gall-bladder and colon, 2; omentum and gall-bladder, 8; omentum and liver, 3; omentum, stomach and colon to liver, 4; obliterating the foramen of Winslow, 1; omentum, stomach and colon to gall-bladder, 1; gall-bladder, liver and stomach, 1; omentum, colon and pylorus, 1; omentum, colon, pylorus and anterior parietal peritoneum, 1; liver and anterior parietal peritoneum, 1; omentum, colon and gall-bladder, 1; omentum, gall-bladder and duodenum, 1. A pericholecystic abscess was found once. The gall-bladder was small in 4 cases; thickened in 9; both small and thickened in 9; distended in 8; and both thickened and distended in 11. Hydrops was present in 4 cases; empyema in 3; and gangrene in 1. The gall-bladder was involved by acute cholecystitis in 1 case; by chronic in 7; by chronic with acute exacerbation in 20, of which 3 showed in addition necrosis, and 1 was hemorrhagic and œdematous. The common bile duct was thickened and dilated in 2 cases. In 2 instances the gall-bladder showed a diverticulum. The stones ranged in number from 1 to 213, and were variously described as yellow or black, round or oval, facetted or mulberry. Gravel was present in 1 case. The quantity of bile varied from a few c.c. to 50 c.c. and was clear or cloudy, reddish, greenish-yellow, or black, and viscid or inspissated. Enlarged lymph nodes around the cystic duct were palpated in 2 cases.

As regards the operative procedures, cholecystectomy was performed 30 times; cholecystostomy, 24; cholecystotomy, 1; and choledochostomy, 19. Drainage was freely used, a rubber tube being placed in the gall-bladder in 24 cases; in the cystic duct in 13; in the common duct in 13; and in the hepatic duct in 6. Supplementary dossils of gauze insulated by either a split rubber tube, or else by rubber-dam, reënforced the primary tubes in 36 cases, and were placed in the fossa of the gall-bladder in 25; in front of and behind the right edge of the lesser omentum in 16; and in the subhepatic region in 18. Examination of the blood revealed hemoglobin percentage between 50 and 70 in 19 cases; from 71 to 80 in 21; and from 81 to 96 in 22. Leukocytosis varied between 3400 and 10,000 in 36 cases; from 10,000 to 20,000 in 19; and from 20,000 to 40,000 in 3. The coagulation time of blood was five minutes or less in 34 cases; and from five to fourteen minutes in 19. In some few instances no blood report was received. Differential leukocyte counts, and examinations of stomach contents and of feces were made with few exceptions.

Interesting pathological features were met with as follows: A spontaneous cholecystogastrostomy, separation of which revealed an opening in the stomach the size of a goose quill, necessitating gastrorrhaphy. In another case the pancreas was slightly enlarged, and a few hard areas were palpated in it; from this patient 13 gallstones, the size of a pea, were removed from the common duct. In another patient, a woman, aged forty years, tissue hyperplasia around the fundus of the gall-bladder, invading the liver for from one-quarter to one-half inch, was seen at operation; the pathological findings revealed, in addition to chronic calculous cholecystitis with acute exacerbation, marked proliferation of the mucous membrane of the gall-bladder, enough to warrant a tentative diagnosis of adenoma. One intrahepatic gall-bladder was found, deeply embedded in the liver, firmly contracted upon contained stones, and shrunken, distorted, and thickened to such extent that certain landmarks were obliterated; a very large, square, faceted stone had partially ulcerated through the fundus of this buried gall-bladder. In 2 cases cholecystectomy was performed because of a distinct diverticulum in the gall-bladder of one, and of a diverticulum near the junction of the cystic with the hepatic duct in another. A gall-bladder that contained 213 stones had to be ablated because some stones were embedded in its mucosa. Another gall-bladder was removed because a stone that blocked the cystic duct could not be dislodged. In this case, several whitish, circumscribed, elevated areas, one inch square, and supposedly carcinomatous, were seen upon the visceral surface of the liver. In a case of cholecystostomy, in addition to a rubber tube with gauze being placed into the gall-bladder, this organ was attached to the anterior parietal peritoneum to meet the indication for prolonged drainage. In another case while cholecystostomy was performed, yet the rubber tube could not be invaginated into the cavity of the organ on account of the thickness of the gall-bladder mucosa.

A few of the many complications of gallstone disease are illustrated in this series. In 2 cases in which the stomach was dilated to a finger's breadth above the navel, there were found numerous adhesions between the gall-bladder and pylorus. Ulceration of the gall-bladder was seen in the case of spontaneous cholecystogastrostomy, and in the case of intrahepatic gall-bladder, in which a stone was caught worming its way through the gall-bladder wall. The adhesions and pericholecystic abscess, the empyema and gangrene of the gall-bladder, and adenomatous degeneration of its mucosa, the chronic pancreatitis and carcinoma of the liver have all been referred to. Empyema of the chest and pneumonia of the right lung were fatal complications in one case. In a patient who had been jaundiced during the ten days previous to operation, from chronic obstruction of the common duct, the liver extended almost to the navel, and was tender—conditions sufficiently accounted for

by finding 31 stones in the common duct, one of which was the size of a hickory nut, another in the ampulla, and 4 more in the left hepatic duct. Chronic appendicitis complicated one case of cholecystitis and 3 of cholelithiasis. I am not prepared to say in these 4 cases whether the appendix was primarily diseased and infected the gall-bladder secondarily through the portal system, or whether the infection extended from the gall-bladder to the appendix. In no instance was there impaction of a gallstone in the appendix, and this was certainly impossible in two of the appendices removed, since both were affected by chronic obliterative appendicitis. It is interesting to observe that a feature common to all 4 of these cases was prolonged indigestion, and this is noteworthy also because there were active simultaneously two of the most frequent causes of this malady, namely, chronic gallstone disease and chronic appendicitis.

Because of its frequency (about 15 to 20 per cent. in my cases), and because of the dire consequences when not removed, I shall say some few words on common duct lithiasis. In 29 out of 182 of my cases stones were found in the common duct and elsewhere, and merely to have removed the stones that were situated elsewhere, thereby overlooking those in the common duct, would have boded ill in any of the 29 cases. In the series of 63 cases of cholelithiasis now reported, stones were found in the common duct in 13. If these stones were not removed, nature might relieve the situation on behalf of the patient by the subsequent permanent external biliary fistula, mutely rebuking the surgeon for his bungling job, and patiently awaiting the aid of re-operation.

Although theoretically infection of the common duct directly from the intestine may be said to be resisted by the oblique intramural segment of the duct, and the presence of the terminal sphincter of Oddi, yet it is obviously impossible to say in how many people these supposed natural barriers have been prophylactic. It is true that the gall-bladder is infected by way of the common duct, though not so frequently as by the portal blood, and this organ is the primary focus for lithiasis of the common duct. While stones in the gall-bladder alone create much mischief, yet here the mischief is confined to a branch only of the biliary tract; but when stones pass out into the common duct and cannot pass through it the main line becomes blocked, and the entire biliary tract more or less involved. Stones in the common duct choke up more or less completely the total excrementitious filtrate of the whole liver, and as this filtrate contains whatever bacteria the portal blood could collect and the liver could not annihilate, the well-known severity of the symptoms of choledochus obstruction can thus readily be accounted for.

When acute this obstruction is complete, but the duct soon dilates from inflammation of its walls and *vis a tergo* of the bile, so that the obstruction becomes incomplete, or chronic, and the stone or stones are now at liberty to carry on the ball-valve action described by

Fenger. Perfectly in accord with the simple mechanical action is the behavior of the jaundice. At first rapidly reaching a deep color from acute complete obstruction, it slowly lifts as the duct dilates to allow partial drainage of the blocked bile, and it alternates at the will of the ball-valve stone. This ball-valve action is significant in several ways. In the first place, it is nature's method of dealing with an emergency by permitting drainage of the pent-up toxic fluids from the biliary vessels into the intestine. Then by variations in the jaundice it as much as tells the surgeon that the ailment is benign, for the jaundice of malignancy develops slowly and progressively and remains for all time. Finally, the ball valve helps to maintain Courvoisier's law by preventing enough backward pressure to dilate the gall-bladder.

Courvoisier's law is, of course, of no use clinically, but often affords a beacon light when the abdomen is entered. If there is chronic jaundice depending upon obstruction of the common duct, a shrunken gall-bladder is significant of calculous blockage of the choledochus, but a dilated gall-bladder indicates some other cause for the obstruction. This shrinkage of the gall-bladder is favored by the ball-valve action of the stone or stones as explained above, and is determined by inflammatory fixation of the contracted organ. Recently, M. R. Barker, of Chicago, has expressed the belief that Courvoisier's law is dependent upon the folds of Heister in the cystic duct: that in calculous obstruction of the common duct the normal action of these folds is not disturbed, thereby preventing dilatation of the gall-bladder by keeping the cystic duct closed; but in obstruction of the duct by pressure of a tumor, the diseased condition has involved either the folds of Heister or the nervous mechanism that controls them, or both, and their normal action is suspended or destroyed, allowing distention of the gall-bladder with bile and its own secretion.

In addition to the ague-like paroxysms of jaundice, colicky pain, and fever with the characteristic "steeple-chart" rises of Moynihan, subjects of choledochus obstruction are very apt to suffer loss in weight, a feature ascribed by Fenger, to "intermittent, frequent, ptomaïne intoxication—that is, bile absorption—as well as to disturbed digestion" (Moynihan). So, too, associated pancreatitis is apt to be another factor. This loss of flesh must be borne in mind when questions of malignancy arise.

Illustrative of the above remarks is the following case: Mrs. S., aged fifty-nine years, had been a sufferer from gallstone disease for seven years, during which time she had had innumerable attacks similar to, but not as severe as, the present. Three months before operation she was afflicted with severe, colicky pain in the right hypochondrium, radiating to the back and right shoulder. The pain was followed by vomiting, and this by chills, fever, and sweats. Three weeks before operation the pain became very severe, the

attacks more frequent, and the jaundice very deep, with clay-colored stools. During the three weeks between this attack and the operation there was very little pain, and the jaundice began to clear, but the skin was very itchy. During these attacks the patient lost nearly 50 pounds in weight.

Examination showed universal jaundice and tenderness over the liver. Anemia to the extent of 68 per cent. of hemoglobin was present, and the blood coagulated within seven minutes.

Operation revealed in addition to adhesions between the omentum, pylorus, colon, and the gall-bladder, a small contracted and thickened gall-bladder free of stones. The common duct was much dilated, being as large as the little finger. A calculus the size of a marble was removed from the ampulla of Vater, and two smaller, irregular calculi from the hepatic duct. Drainage of the common duct was effected by a rubber tube, and of the sub-hepatic region and area in front of the lesser omentum, by Mikulicz drains.

By no means, however, will all cases be found so typical. In the absence of impaction no jaundice whatever may develop, and no severe pain arise. Endless modification of symptoms may be met with. Nevertheless, even in the absence of jaundice the common duct should always be determined free of stones.

In recent years pancreatitis has been recognized as a complication of gallstone disease. A small stone impacted in the ampulla of Vater may convert the bile and pancreatic duct into a single channel, thereby causing retrojection of bile and acute pancreatitis from irritation of the bile salts (chemical pancreatitis) and from the accompanying infection. Chronic pancreatitis may arise from extension of the inflammation from the common duct into the pancreas through the duct of Wirsung. Robson found pancreatic catarrh or interstitial pancreatitis in more than half his cases of common duct lithiasis. This is somewhat higher than the experience of W. J. Mayo who stated recently that in 268 operations on the common and hepatic ducts the pancreas showed disease in 18.6 per cent. I have found chronic pancreatitis in about 11 per cent. of my fatal cases of cholelithiasis. I report on these fatal cases, because in the living the diagnosis of chronic pancreatitis by palpation is very fallacious. As Richardson recently stated: "I would therefore exclude from all consideration of scientific accuracy my own cases, at least of so-called chronic pancreatitis, for their existence has never been proved by section, by microscope, or by autopsy. Palpation in these cases should always be directed first to the triangle of pancreatic inflammation, recently described by Mayo. This triangle is that part of the head of the pancreas which lies between the duodenum on the right of the ducts of Santorini above and Wirsung below. It is here that the organ is first infected."

If a stone in the common duct compresses the duct of Wirsung, the duct of Santorini will maintain pancreatic excretion in nearly

half of the cases (Mayo). Letulle and Nattan-Larrier found that in 10 per cent. of patients the common bile duct and the duct of Wirsung empty into the duodenum by separate orifices, and it might be supposed that in this way the pancreas would be exempt from involvement. This is true in so far as chemical pancreatitis is concerned, but inflammation could yet spread from the common duct into that of Wirsung by travelling along the small extent of duodenum between them, and this, perhaps, explains the pancreatic involvement cited in New's case (cited by Egdahl), in which gallstones were present, but the duct of Wirsung had a separate opening. In this connection it would be interesting to learn if the pancreas is ever infected from the duodenum through the duct of Santorini when this is present. Opie has well said that in this unfortunate association of terminal facilities the large percentage of known diseases of the pancreas have their etiology (cited by Mayo).

I have recently operated upon two cases of acute suppurative pancreatitis, both of which showed fat necrosis. Both cases were drained retroperitoneally, and both recovered. In only one, however, was associated gallstone disease found. Furthermore, pancreatic cysts also may arise from pressure of a gallstone upon the duct of Wirsung.

It is my routine practice in all cases of gall-bladder affections, in addition to examination of the blood and stomach contents, to have the feces examined. Fatty stools in the absence of jaundice are very significant of chronic pancreatitis. If the urine shows glucose, and if it yields the acicular crystals of Cammidge's test, the diagnosis of pancreatitis is strengthened. My experience with Cammidge's test has been limited to the latest two cases of suspected pancreatitis admitted in hospital. In the first case the test was positive; in the second, it was positive at the first trial, but negative at the second. Of these, one did not have the disease, and if the other patient had pancreatitis, no opportunity of proof by operation could be had.

The medical treatment of gallstone disease may be disposed of in a few words. The task of dissolving gallstones or absorbing adhesions by medical means may be conservatively estimated as about equal to the twelve labors of Hercules, or the recurring toil of Sisyphus. The Carlsbad treatment is very useful to hasten convalescence from gallstone operations, and is a good place for those who, in the absence of contra-indications, refuse to be operated upon, since it promotes mental peace.

I shall speak somewhat more fully on the surgical treatment. In my experience the cases to which the prophylactic treatment for gallstones could be applied were those referred to me early by physicians. In such cases the contents of the gall-bladder showed the formative elements of undeveloped gallstones, and the draining away of such material usually resulted in cure. After gallstones

have formed the risk of operation is the risk of delay, as I think I have shown throughout this paper.

My operative technique has recently been described[4] so that it is unnecessary to repeat it now. The principles that govern me in operations on the biliary passages are, in the first instance, those common to all abdominal operations, namely, to get in the abdomen as quickly as possible, to remain there as short a time as possible, and to get out as soon as possible, doing only that which seems necessary to restore the patient to health. I take pains in the proper disposal of packs, so as to wall off the operative field as completely as possible. Adhesions are avoided when they do not interfere with the proper execution of the operation. The biliary tract is searched for stones, and all that are encountered are removed. Free and sufficient drainage is instituted according to the requirements of each individual case. Postoperative treatment must be watchfully and intelligently supervised.

I do not favor cholecystotomy or choledochotomy without subsequent cholecystostomy or choledochostomy, and I believe that with the elimination of these two procedures the statistics of postoperative peritonitis would be considerably reduced.

Cholecystectomy is a procedure I avoid when possible. The gall-bladder should not be removed unless we feel that in its ablation we are taking away a menance to the future health and comfort of our patient. Sidney Phillips has well said that it is impossible for the surgeon to devise so perfect an automatic mechanism for storage and intermittent distribution of bile as the gall-bladder. Aside from the danger of hemorrhage attending cholecystectomy, we must look into the patient's postoperative future. If a second operation should at any time be required, we may be only too glad that we have previously preserved the gall-bladder as a valuable agent for drainage of the biliary tract, and that the operative field is comparatively free of adhesions, as is not likely to be the case if the gall-badder has been removed.

ASCITES IN TYPHOID FEVER.[1]

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Peritoneal effusion in typhoid fever, apart from peritonitis, must be of rare occurrence, as there is no reference to in it the literature on the subject. During the last three years six cases presenting

[4] Surg., Gynec., and Obstet., January, 1908, 61.

[1] Read at a meeting of the Association of American Physicians, Washington, D. C., May 12 and 13, 1908.

signs of such effusion have come under my observation. In all of them the effusion occurred during the course of the illness, persisted for about ten days or two weeks, and disappeared in all but one with convalescence. In all the cases the illness was severe, but in none were there hemorrhages or symptoms of peritonitis, except in one case.

CASE I.—The most marked case was that of a woman, aged thirty years, who was married, had two children, and came from the foothills of the Rocky Mountains in October, 1907. On her arrival she was very ill, her temperature being 104° F. She had severe bronchitis, with loud rales of great variety and some wheezing in all parts of the chest. She had a history of asthmatic attacks extending over some years. The sputum was frothy and copious, but contained no spirils or eosinophiles, nor was the dyspnœa paroxysmal. After a few days it became evident that she was suffering from typhoid fever, all the usual symptoms of which were presented later—the rose-colored spots, enlarged spleen, leukopenia, Widal reaction, low blood pressure, etc. The abdomen was not at any time distended, but remained relaxed throughout. The course of the disease was severe and protracted, but otherwise uneventful. She showed marked prostration. In the third week after she was first seen both flanks became full and fluctuating in the dorsal position. The note to light percussion was flat to the mammillary line; on deeper percussion there was slight tympany of an amphoric character. Fluctuation was easily demonstrated. When turned on her side the upper flank became concave and somewhat tympanitic; the dependent one full and rounded with fluctuation and flatness well marked to the parasternal line. That these signs were not due to fluid feces in the colon was shown by the fact that no alteration in them resulted from the action of a copious enema. A purgative was then given; it acted freely but without affecting the signs of free fluid effusion. The quantity of fluid varied, diminishing somewhat on one or two occasions, and then increasing again, until toward the end when it gradually lessened and disappeared, leaving the flanks retracted. At the same time the temperature became normal, and convalescence was soon established.

CASE II.—A laborer, aged twenty-two years, with good personal and family histories, was admitted to the hospital September 22, 1905. He said he had had typhoid fever during the preceding year. However, the symptoms of the present attack were quite marked: the usual temperature, some diarrhœa, moderate abdominal distention, rash on the chest and abdomen, enlarged spleen, leukocytes as low as 4500, and well-marked Widal reaction. The illness was protracted, there being apparently a series of intercurrent relapses. The signs of fluid in the peritoneal cavity became apparent October 23, in the beginning of the fifth week, and were quite marked until December 6, after which they gradually abated, and

were not evident ten days later. The abdomen was quite relaxed throughout the illness, and was not tender on deep palpation. His convalescence was satisfactory, and he left the hospital in good condition. The sputum was scanty, but in such as there was obtained no tubercle bacilli were found on repeated examinations.

CASE III.—A man, aged thirty-five years, a clerk, was in the hospital at the same time as Case II. On admission the abdomen was tympanitic in all parts, including the flanks. The rash was profuse and widespread. Two days after admission the flanks were found full, flat on percussion to the mamillary line, and with fluctation quite distinct. The signs of effusion lasted over three weeks and disappeared with convalescence. His recovery was satisfactory.

CASE IV.—A young man, entered the hospital in January, 1908; the symptoms of typhoid fever were well marked. About the end of the second week of illness signs of moderate peritoneal effusion developed, persisted for two weeks, and then disappeared rather rapidly. The ophthalmotuberculin test was made without any reaction following. After the temperature had been normal three days pleuritis of the left side began with much pain and moderate fever. The exudate was fairly free, although no fluid was obtained by the aspirating syringe. To determine whether it was due to tuberculous infection, a further test was made with old tuberculin subcutaneously. No reaction resulted.

CASE V.—The patient was a girl, aged fifteen years, whom I saw but once, in consultation with her physician, in the second or third week of her illness. There was a large quantity of fluid in the peritoneal cavity; the signs were first observed on the preceding day, although the effusion had probably been present for some time. The illness was severe, the temperature being over 104° F. There was no pain or tenderness in the abdomen; its walls were not rigid. Her physician informed me that signs of fluid disappeared a few days later, the patient making a good recovery.

CASE VI.—In this case the effusion was probably due to tuberculous peritonitis. A man, aged twenty-three years, was admitted to the hospital September 24, 1907, with a temperature of 101.8° F.; pulse, 80. He was employed washing in a garage and a fellow worker occupied the next bed, having taken ill at the same time. The symptoms of typhoid fever were well defined in both cases, and the disease ran a rather severe course. In the fourth week there occurred phlebitis of the left saphenous vein, with marked chills, the temperature rising to 108.4° F. after the first chill. A few days later there were signs of some exudate into, first, the left, and then the right pleura. Two weeks later, and seven weeks after admission, there were well-defined signs of peritoneal effusion, the quantity being greater than in any of the preceding cases. The abdominal wall was rather rigid and somewhat tender to firm pressure. The

temperature was slightly, but irregularly, elevated, and the leukocytes, which had been below 5000, rose to 12,000. A tuberculin test was made; there was no reaction to 0.5 milligram given subcutaneously, but 2 milligrams caused a well-marked reaction. Later, there was marked reaction to the ophthalmotuberculin test. His general condition improved, although the peritoneal exudate persisted. He left the hospital January 21, 1908, in good condition, but with a considerable quantity of fluid still in the abdominal cavity.

In at least four of these six cases the effusion, so far as can be determined, was due to pathological conditions resulting from typhoid infection. The immediate cause of the effusion is uncertain. The disease was severe and attended by much prostration. The abdomen was very relaxed and the contents therefore had little support, so that the vessels would easily dilate, permitting considerable stasis, or at least marked slowing of the current of blood, thus favoring serous exudation. It is possible, also, that the mesenteric glands were greatly enlarged, causing slight but sufficient irritation of the peritoneum to excite effusion.

Toxemia is another possible cause of the effusion. In hepatic cirrhosis something more than simple obstruction to the portal vessels is required to cause ascites. This may be a toxic substance which affects the hepatic cells so as further to obstruct the portal circulation, or alters the peritoneal epithelium so as to permit a more rapid escape of serous exudate and possibly also cause obstruction of the peritoneal lymphatic vessels, so that the exudate is less readily removed.

It is probable that in other diseases attended by prostration moderate effusion into the serous cavities may be more frequent than is suspected. Recently in a case of empyema with a bronchial fistula, there were signs of peritoneal effusion for some days during a period of marked prostration and moderate toxemia; they disappeared with the improvement in the general condition. Even in hepatic disease ascites may disappear rapidly, and that, too, without improvement in the patient's general condition. Such was the case in a woman who entered the hospital last winter with marked jaundice and ascites of recent onset. After a few days both the jaundice and ascites rapidly diminished and disappeared, although her general condition was growing worse. She gradually became comatose and died a few days later.

LOBAR PNEUMONIA.

A STUDY OF 445 CASES, WITH SPECIAL REFERENCE TO THE DECREASED MORTALITY SINCE THE INSTITUTION OF THE FRESH-AIR TREATMENT.

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The following study is based on a consideration of 445 cases of croupous pneumonia admitted to the Philadelphia General Hospital between February 1, 1905, and December 23, 1907. The data were collected from the clinical histories, in a considerable number of which the facts had been verified by postmortem examination. All cases, which, by the latter method, proved to be instances of miliary tuberculosis, hypostatic pneumonia, etc., were excluded from this compilation. February 1, 1905, was chosen for the beginning of the present study, since this time marks the beginning of the fresh-air treatment, the pneumonia patients being isolated in a special ward in which the windows are constantly kept wide open regardless of weather or temperature. The statistics of males and females have been kept separately for the special reason that women with pneumonia, owing to lack of room and the relative fewness of their number, are still treated in the general medical wards in which only the ordinary hospital ventilation is employed, the windows being generally closed during the cold months of the year when most of the cases occur. Some years ago, before the institution of the fresh-air regime, a similar study of the pneumonia cases in the same hospital was made by Ashton and Landis,[1] based on a study of 991 cases. Since there has been no change in the character of the patients coming under observation or in the methods of treatment employed, except the constant and liberal supply of fresh air, it is interesting to compare the result of the two series of cases.

As was pointed out by Ashton and Landis, in considering pneumonia as it is seen at the Philadelphia General Hospital, we are not confronted with average, but with extreme and somewhat unusual types of this disease. The patients with whom we have to deal are, in the vast majority of instances, far advanced in years—inmates of the almshouse—who have come to await death within its portals. Nearly all of them are the subjects of advanced states of degeneration of their various viscera, among which high-grade arteriosclerosis and chronic nephritis are not the exception, but the rule. The foregoing statements apply with equal truth to the large number of

[1] Amer. Jour. Med. Sci., June, 1905.

patients afflicted with insanity or chronic nerve disease who contribute to our large mortality. The second class of cases with whom we have to deal are, from a therapeutic standpoint, no less discouraging, namely, the large number of tramps and habitual drunkards who have reached the lowest depths of depravity and vice, who often wind up a prolonged debauch with an attack of pneumonia and are brought to the hospital with delirium tremens or in a moribund condition.

I was led to collect the present series of statistics by the fact that a considerable number of what appeared clinically to be hopeless cases recovered, and I wished to verify my impression. The mortality in Ashton and Landis' series was over 53 per cent. The general mortality in the present collection was 47 per cent., not a great difference it would seem at first sight; but when we eliminate the female cases we find that 170 among 383 males died, giving a mortality of 43.6 per cent., or 10 per cent. less than before the fresh-air treatment was adopted. If from this number we subtract those that died within twenty-four hours of admission—moribund when admitted—we get a mortality of 38 per cent. This, of course, is still considerably above the average of 25 per cent., which obtains throughout most of the hospitals the world over, but when we consider the class of cases with which we have to deal it is not so bad. Of the women on the other hand, of whom there were but 62 in the present series, 40 died—a death rate of 64.5 per cent.; excluding those who died within twenty-four hours of admission—2 in all—we still are confronted with a mortality of 61.3 per cent. This is extremely high even allowing for the fact that the mortality among women is generally greater than in men. This may be construed as evidence detracting from the beneficial effects of the fresh-air treatment, since in Ashton and Landis' series the male and female statistics were not separated, and their high mortality may have been largely the result of female deaths, the number of which was not stated. I am, however, of the belief that the decrease in mortality more than counterbalances the influence of the female deaths in the first series, a fact which is apparently substantiated when the total death-rate of the two series is compared (53 per cent. against 47 per cent.). Another element which tended to prevent a still greater reduction in mortality was the fact that a number of the male patients did not receive the fresh-air treatment during their whole stay in the hospital, since it is not the custom to transfer cases to the pneumonia ward until a positive diagnosis has been reached.

Aside from the constantly open windows and door there has been no innovation in the method of treatment employed. For the most part therapeusis has been symptomatic in character, mainly sedative or stimulating as the individual case seemed to demand. In other words, active delirium and insomnia were treated with bromides, opium, etc., asthenic cases with strychnine, caffeine, ammonia, digi-

talis, etc. It seems to me that in the average case perhaps too much stimulation has been employed. Owing to the erroneous conception of the pathology and therapeusis of pneumonia with which the average resident physician enters the hospital, it seems to be his almost invariable custom to prescribe strychnine from the beginning, to "keep up the strength" despite the fact that the patient's condition may be quite satisfactory without any stimulation whatever. The use of alcohol seems to be steadily falling more and more into disfavor, and justly so, since this drug does more to relax the vasomotors than to stimulate the heart; and it has been quite definitely shown by the experimental researches of Paessler and Rolly that the vasomotor system is the one which causes death in pneumococcic infection, and not the heart. It is not my purpose to take up the apparently endless question as to whether alcohol is or is not a food, but it does seem to me to have been shown by Bachman that alcohol possesses no power of sustaining action in an isolated rabbit's heart, such as does, for instance, grape sugar. On the other hand, it seems to be a fact based on prolonged clinical observation that habitual topers, when attacked by pneumonia, are often benefited by reasonable amounts of this drug. Hay, who collected statistics of 150 pneumonia patients, found the mortality 15 per cent. lower among those who did not receive alcohol.[2] Eserine has been employed beneficially in a number of cases in which there was marked tympanites, an extremely serious symptom which generally bespeaks a high grade of toxemia, and exerts a very deleterious action on the circulation, respiration, and digestion.

Sponging with cold water has been used quite frequently and with good results, not so much for the purpose of reducing the temperature, which it does very satisfactorily, but more with a view to toning up the vasomotor system, for which purpose it seems to be our most useful remedy.

Digitalis is still used to an astonishingly large extent when one considers the impotency of this drug in febrile cases, a fact which has been repeatedly pointed out by careful observers, but which does not seem to be generally recognized. Personally, I have never been convinced that digitalis accomplished anything in cases having any considerable degree of fever. The inaction of digitalis in pneumonia was, I believe, first pointed out by Thomas,[3] in 1865. Inasmuch as digitalis acts on the heart chiefly through the vagus, it would seem that its failure in effect might result from paralysis of this nerve, since it has been shown by Schleske and Cyon that high temperatures in frogs do bring about such a paralysis; furthermore, Liebermeister's experiments in mammals indicated a similar state of affairs. Brunton,[4] however, who has especially studied this point,

[2] Lancet, 1904, 1, 1643

[3] Arch. f. Heilk., 1865, p. 329.

[4] Circulation and Respiration, 1906.

found that "in the rabbit and probably other mammalian hearts, a temperature sufficiently high to produce stoppage of the heart, does not paralyze the vagus or the inhibitory apparatus through which it acts;" although "it is possible that a longer exposure to a high temperature, such as occurs in fevers, may produce this result."

COMPLICATIONS. Among 445 cases (males and females being included) *acute pericarditis* was encountered 8 times, all of the cases being fatal. This incidence of pericarditis in 1.7 per cent. of the cases corresponds very closely to the general literature on the subject from which the following statistics were collected:

	Pneumonia.	Pericarditis.
A. H. Smith	485	6
M. Huss	2616	22
Townsend and Coolidge	1000	3
Leudet	83	6
Ormerod	268	33
Flint	133	8
Behier	114	3
Dusch	369	3
Sturgis and Coupland	161	3
Collective Invest Rep.	1056	2
Biach	11,442	62
Sturges	16	6
Fismer	460	13
Spence	201	7
Hadden, McKenzie, and Ord	708	19
Schleinger	173	4
Musser	489	6
Norris	500	4
Ashton and Landis	991	1
McCrae, Fyshe, and Ainley	486	16
Pye-Smith	434	14
Sello	750	7
Sears and Larrabee	949	19
Meyer	500	5
Juergensen	5738	27
Grisolle	58	3
Chatard	665	31
Poehlmann	239	5
Hay	200	9
Anders	275	14
Austin	70	3
Petzold	271	4
Kaller and Lefebvre	100	1
Rychner	616	17
Doubleday	254	6
Meltzer	4252	46
Biach	4231	20
West	100	3
Satterthwaite	55	5
Audeoud	419	5
Jackson	1320	22
Geo. W. Norris	445	8
Total	43,722	501 (1.1%)

Acute endocarditis occurred 3 times. All of the cases terminated fatally. The collected literature on this subject is as follows:

	Pneumonia.	Endocarditis.
Aufrecht	1501	1
Fismer	230	2
Wells	6050	19
Liebermeister	204	1
Sello	750	6
McCrae, Fyshe, and Ainley	486	14
Musser	489	1
Becker	415	1
Meyer	500	5
Norris	500	5
Rychner	616	8
Pye-Smith	434	7
Juergensen	5738	11
Dusch	369	4
Petzold	271	1
Hadden, McKenzie, and Ord	708	1
Collect. Invest Rep.	1065	1
Austin	70	1
Hall	70	1
Huss	2616	4
Baeck	340	1
Biach	6885	15
Croce	610	6
West	100	0
Sears and Larrabee	291	9
Chatard	658	13
Omerod	183	6
Audeoud	419	4
J. M. Clarke	126	1
Geo. W. Norris	445	3
Total	33,139	153 (0.46%)

Empyema occurred only twice in the present series. One case ended fatally, the other recovered. My collected statistics show the following incidence:

	Pneumonia.	Empyema.
Chatard	658	27
Middlesex Hospital	267	9
Coll. Invest. Rep.	1065	5
Spence	201	4
Gaitskell	10	1
Townsend and Coolidge	1000	6
Hadden, MacKenzie, and Ord	708	6
Musser	489	9
Norris	500	6
Ashton and Landis	991	3
Aufrecht	1501	24
Meyer	500	12
Sello	750	34
Sears and Larrabee	949	19
White and Pearce	1341	45
Pye-Smith	434	24
Futcher	48	1
Hall	70	5
Poehlmann	239	7
A. H. Smith	488	10
Kaler and Lefebvre	100	1
Schlesinger	173	7 children
McCrae, Fyshe, and Ainley	486	18
Doubleday	252	15
Fismer	230	4
West	100	1
Audeoud	419	22
Jackson	1320	22
Morse	118	9 children
Geo. W. Norris	445	2
Total	15,852	358 (2.2%)

Pulmonary abscess was encountered in two instances, one of them ending in death. My collected statistics are as follows:

	Pneumonia.	Pulmonary abscess.	
Huss	2616	20	12 fatal
Sturges and Coupland	267	1	
Grisolle	280	1	
Bamberger	186	1	
Morehead	189	5	
Spence	201	1	1 fatal
Flint	133	4	2 fatal
Aufrecht	1501	3	
Musser	489	2	2 fatal
Steven	120	2	2 fatal
Sello	750	11	
Lebert	898	4	
Sears and Larrabee	949	3	
Baeck	340	1	
A. H. Smith	304	1	1 recovered
Norris	500	0	
Poehlmann	239	1	1 fatal
Rychner	616	0	
St. Barts Hospital	1165	2	
Doubleday	252	1	
West	100	1	
Satterthwaite	55	0	
Elsner	150	11	
Fismer	230	0	
Audeoud	419	1	
Jackson	1320	1	
Geo. W. Norris	445	2	1 fatal
Total	14,214	83	(0.5%)

No cases of *pulmonary gangrene* were recorded.

Meningitis was noted in 3 instances, with 2 deaths. In addition to these cases, there were 2 which presented marked symptoms indicating meningeal irritation, such as headache, vomiting, cervical rigidity or retraction, and delirium, but in which no actual palsies or occular neuritis occurred. Both of these cases recovered. They were, therefore, classified as "meningismus," probably the result of toxemia. A diagnosis between the two foregoing conditions is often difficult, but, as a rule, may be settled by lumbar puncture. The collected statistics added to the present series give the following table:

	Pneumonia.	Meningitis.	Died.
Huss	2616	2	2
Dusch	630	7	
Coll. Ivnest. Rep.	1065	1	
Biach	11,422	15	15
Chomel	50	5	
Townsend and Coolidge	1000	1	1
Norris	500	4	1
Becker	505	1	1
Flint	133	1	1
Musser	489	1	
McCrae, Fyshe and Ainley	486	23	
Sears and Larrabee	949	7	
Meyer	500	5	
Chatard	658	13	13
Aufrecht	1501	4	
Nauwerk	1172	14	
Sello	750	5	
Juergenson	5738	8	
Fismer	230	6	
Fraenkel	750	5	
Firket	16,333	64	
Poehlmann	239	1	1
Rychner	616	7	
Mueller	444	2	
Doubleday	252	4	4
Audeoud	419	12	12
Jackson	1320	3	
Geo. W. Norris	445	3	2
Total	51,212	234 (0.4%)	53 (Mortality 93%)

Acute arthritis as a complication occurred 3 times, twice ending in death. This is one of the rarer complications, which we find with increasing frequency in the later statistical study of pneumonia, for the reason that the joint involvement has in the past been attributed to an intercurrent rheumatism. It is, however, a true complication due to the local action of the pneumococcus. The condition has been so carefully studied and described by Cave, Herrick, and others, that a further consideration is at present unnecessary. In the literature the following cases have been reported:

	Pneumonia.	Arthritis.	Died.
Huss	2616	22	2
Coll. Invest. Rep.	989	8	
Grisolle	201	4	
Fox	53	1	
Spence	201	1	
Townsend and Coolidge	1000	8	1
Hadden, MacKenzie, and Ord	708	40	13
Musser	489	5	1
A. H. Smith	488	0	
Sello	750	1	
Ashton and Landis	991	2	0
Norris	500	1	1
Cave	2292	2	
Sears and Larrabee	949	23	7
Netter	4156	6	
Ziemssen	3293	2	
Fismer	230	1	
Raw	817	7	3
Petsold	271	3	
Hall	70	1	
Riessell	445	2	
Rychner	616	0	
Vogelius	5158	6	
Hermann	235	1	
Poehlmann	239	0	
Sainter	331	0	
Audeoud	419	3	2
Croce	610	1	
Jackson	1320	1	
Clarke	126	1	
Geo. W. Norris	445	3	2
Total	30,113	158 (0.5%)	32 (Mortality 28%)

Otitis media occurred in 6 cases, 1 of which ended fatally. This is one of the complications which occurs more frequently in children than in adults, a fact which accounts for the paucity of these cases in the present series. It not infrequently produces symptoms which simulate meningitis, even when no actual meningeal involvement has occurred. A careful aural examination, in cases of penumonia presenting atypical symptoms, is too frequently neglected. The collected statistics are as follows:

	Pneumonia.	Otitis.	Died.
Dusch (children)	173	18	
Gross	314	2	
Coll. Invest. Rep.	1065	2	
Norris	500	2	0
Becker	505	1	
McCrae, Fyshe, and Ainley	486	19	
Sears and Larrabee	949	16	
Pye Smith	434	3	
Hall	70	1	
Futcher	48	1	
Morse (infants)	118	21	
Musser	489	4	2
Doubleday	252	2	0
A. H. Smith	488	6	0
Schlesinger (children)	173	18	
Geo. W. Norris	445	6	1
Total	6508	122 (1.8%)	3 (Mortality 1.5%)

Parotitis, another of the less common complications was recorded once, and this case terminated favorably. The infection of the gland in these cases may be either hematogenous or by way of Steno's duct. Comparing our incidence percentage with the general literature, we find:

	Pneumonia.	Parotitis.	Died.
Sturgis and Coupland	123	1	
Mueller	444	1	
Norris	500	1	0
McCrae, Fyshe, and Ainley	486	4	
Sears and Larrabee	949	2	1
Musser	489	1	0
Flint	131	1	1
Geo. W. Norris	445	1	0
Total	3575	12 (0.3%)	2 (Mortality 16%)

Acute peritonitis occurred only once in the present series, and ended in death. A good deal has been written on the subject of pneumococcic peritonits lately, since primary peritonitis due to this cause is of no great rarity. Inasmuch as infection may take place through the genito-urinary tract, the condition is more common in females. Hematogenous and gastro-intestinal infection, according to Sulzer, also occur. In a good many of the cases there is a tendency for the inflammatory process to become encysted, and unless evacuated by incision, to rupture into the umbilicus, intestines, bladder, scrotum, etc. In cases secondary to pneumonia such events so far as I know have not been reported. Peritonitis complicating pneumonia has been reported as follows:

	Pneumonia.	Peritonitis.	
Fawcett	182	5	
Mueller	441	1	
Townsend and Coolidge	1000	2	1 fatal
Musser	489	1	1 "
Sears and Larrabee	949	3	3 "
Norris	500	1	1 "
Poehlmann	239	1	1 "
Rychner	616	4	
A. H. Smith	428	0	
McCrae, Fyshe, and Ainley	486	3	
Hadden, McKenzie, and Ord	708	0	
Doubleday	252	3	3 fatal
Chatard	658	3	
Sello	750	1	
Pye-Smith	434	0	
Audeoud	419	0	
Clarke	126	2	
Geo. W. Norris	445	1	1 fatal
Total	9221	31 (0.3%)	11 (Mortality 92%)

Acute colitis occurred in 4 cases; none of these recovered. *Phlebitis* was encountered once, the femoral left vein being involved,

with eventual recovery. The *urine* was examined for albumin in 397 cases; it was found in 311 (78 per cent.); 136 of these died (34 per cent.). Albumin was absent in 86 cases, of which 27 died (31 per cent.). There were records of 382 microscopic examinations. Casts were found in 236 cases, of which 106 died (27 per cent.). They were absent in 130 cases, of which 63 died (49 per cent.). Aside from these examinations a clinical diagnosis of acute nephritis was recorded 16 times, in 14 of which a fatal termination occurred (87 per cent.). It will be seen, therefore, that acute nephritis is one of the most serious complications of pneumonia. In the general literature the condition has been reported as follows:

	Pneumonia.	Acute nephritis.	Died.
Juergensen	5738	66	
Huss	2616	52	
Fismer	230	1	
Zurich	500	13	
Meyer	500	3	
Norris	500	3	
Becker	505	2	
Nauwerk	550	14	2
Musser	489	6	4
Sello	750	6	
Aufrecht	1501	16	
Rosenstein	130	2	
Wagner	150	4	
Fraenkel and Reiche	956	6	4
Ashton and Landis	991	5	3
Mayer	44	2	
Petzold	271	7	
Hadden, McKenzie, and Ord	708	3	1
Townsend and Coolidge	1000	9	4
Dusch	369	3	
Sturgis and Coupland	91	14	
Spence	201	8	4
Flint	133	2	
Audeoud	419	6	6
Clarke	126	1	
Poehlmann	157	1	
Morhart	139	2	
Baeck	340	6	
Geo. W. Norris	445	16	14
Total	20,107	263 (0.5%)	42 (Mortality 57%)

The following list shows the diseases in which pneumonia appeared as an intercurrent infection, frequently a terminal one. The gravity of the affections is such as to require no comment on the high mortality which resulted:

	Total.	Died.	Mortality. Per cent.
Chronic nephritis	45	41	93
Delirium tremens	24	18	64
Arteriosclerosis[5]	36	36	100
Myocarditis	22	21	95
Alcoholism[5] (in addition to the above)	62	37	59
Uremia	5	5	100
Chronic endocarditis	5	5	100
Mitral	10	8	80
Aortic	4	2	50
Erysipelas	7	6	85
Pulmonary tuberculosis	16	9	56
Hepatic cirrhosis	2	2	100
Insanity	4	3	75
Syphilis[6]	10	5	50
Morphinism	1	1	100
Hemiplegia	1	...	...
Measles	3	3	100
Pertussis	2	2	100
Typhoid fever	3	3	100

The extremely high mortality, which is shown in the foregoing table in the chronic nephritis cases, is due to the fact that only the severe types of this disease were recorded in the clinical diagnosis as such. As has been previously pointed out, albumin was found in the urine in 78 per cent. of the cases, and casts in 53 per cent.

The *sputum* was examined in 156 cases, with the following results:

	Times.
Pneumococcus present	139
Pneumococcus absent	10
Streptococcus present	4
Staphylococcus present	2
Micrococcus catarhalis present	2
Streptothrix	2

Blood cultures were made in 16 cases; and the following organisms were found:

	Times.
Pneumococcus present	8
Staphylococcus present	2
Negative results	4

Four patients in whom pneumococci were cultured from the blood recovered, 2 died. Of the 4 cases in which blood cultures were sterile 3 died and 1 recovered One pure staphylococcus case recovered. One in which the last-named organism and the pneumococcus were found together died. It will be seen, therefore, that no prognostic conclusions can be drawn from the presence of pneumococci in the blood. The frequency with which they are recovered is largely

[5] The frequency of this condition is certainly underestimated. In many histories the condition was unrecorded except when very striking objective appearances were present.

[6] The proportion of intemperate subjects is also underestimated in the histories. Only those cases were collected in our statistics which were put down as habitual drunkards or in words to that effect.

a question of technique. It is probable that in every case pneumococci gain entrance to the blood stream. Cases have been reported in which this organism has been recovered from the blood when there was no evidence of pneumonia or any other grave systemic disease. The recent experiments of Tizzoni and Panichi[7] have shown that the pneumococcus may remain in the blood of animals for months after inoculation regardless of whether or not an active or passive, a partial or a complete, immunity had been developed previous to the inoculation. They have suggested, therefore, that recurrence of attacks of pneumonia are due to the fact that the organism has never been eliminated from the blood, and that some temporary lowering of resistive power has enabled them to gain a fresh foothold and renewed virulence. These authors also found that in some animals infection was unattended by symptoms of illness, but that if a trauma was inflicted, localized infection occurred at the point of injury, and sometimes ended fatally. In the present series there were 2 cases which followed close upon injury to the chest. One of these cases died, one recovered.

Pneumococcemia, or the presence of this organism in the oral or respiratory passages of apparently healthy people, explains how a temporary reduction of individual resistance may precipitate an attack of pneumonia. It has been shown experimentally, by Lode and Lipari, that the old idea about chilling of the body as a predisposing factor of pneumonia rests on a solid basis. The first-named author found that animals shaved to the extent of one-half or one-third of their integument, if exposed first to heat, then to cold, and finally inoculated with pneumococci, developed pneumonia and pleuritis much more frequently than did the controls, the ratio being as 85 to 12.

Leukocyte counts were made in 189 cases. When more than one count was made the highest was taken for our statistics:

	Cases.	Died.	Mortality. Per. cent.
Below 10,000 leukocytes	27	11	40
Between 10,000 and 20,000 leukocytes	81	25	32
Between 20,000 and 30,000 leukocytes	55	14	25
Between 30,000 and 40,000 leukocytes	17	6	35
Between 40,000 and 50,000 leukocytes	6	3	50
Between 50,000 and 60,000 leukocytes	2	0	0

These figures illustrate what is, I believe, generally accepted regarding the prognostic significance of leukocytes, namely, a count ranging between 10,000 and 30,000 is most favorable. Higher figures often indicate suppurative complications and are, therefore, to be regarded with suspicion; whereas, leukopenia bespeaks lack of reaction and is, therefore, to be unfavorably interpreted. The highest count met with in the present series was 57,000 and occurred

[7] Centralbl. f. Bakt., 1905, xxxvi, 25.

in a case complicated by phlebitis, which subsequently developed an abscess of the lung, but eventually recovered. Of late a renewed interest has attached itself to the question of leukocytes in relation to the opsonic index. The subject has been studied by MacDonald[8] Wolf,[9] Potter, and Krumwiede,[10] and quite uniform results have been reported. During the early stages of pneumonia there is a subnormal opsonic index, which in favorable cases increases gradually, and at the time of the crisis rises considerably above the normal. Wolf found that as the opsonic index increased the actual number of leukocytes diminished, making it appear that in the early stages the increased number of white corpuscles counteracted the deficiency of the opsonic power, a fact which has apparently been substantiated by Rosenow's[11] investigations. The opsonic index was examined in only one case of the present series, in which it was reported as being 2.15 on the day of the crisis. Rosenow found that an inverse relation existed between the number of leukocytes and the number of pneumococci in the blood.

Among the somewhat unusual and interesting results tabulated, the following may be mentioned:

Three patients passed intestinal parasites while in the active stage of pneumonia; 2 of these died. Attention has long been called to the fact that such an event occurs.

Nine of the patients were in their second attack; of these 6 died, a somewhat unusual occurrence, since second attacks are often milder than primary ones; 4 of the patients were attacked for the third time; 3 of these recovered. I have no doubt that these figures underestimate the frequency of repeated attacks. The question is often not put by the resident physician who takes the history, and in very many of the cases, owing to the patient's inability to speak English, or to the fact that they were admitted in a delirious condition no history was obtainable.

Delayed resolution occurred 6 times. All of these patients eventually recovering at least to the extent of being able to leave the hospital. Relapses occurred in 4 cases; 2 of these died.

So-called ether or operative pneumonia occurred in 3 instances, 1 of these terminating in death. The etiology of this condition is somewhat obscure. There are a number of predisposing factors which come into play: (1) It has been shown by Snel that ether reduces the bactericidal power of the lungs; (2) chilling of the body which occurs as the result of a loss of heat from the skin and the respiratory passages may play a part; (3) some cases are purely coincident and would have been disclosed if the lungs had been carefully examined before the operation; (4) pneumonia occurs after operations in which no ether is used, even when

[8] Trans. Path. Soc., London, 1906, lvii, 45.
[9] Jour. Infect. Dis., 1906, iii, 731.
[10] Ibid., November, 1907.
[11] Jour. Amer. Med. Assoc., 1905, 871.

done under local anesthesia, especially after abdominal sections, and apparently result from emboli; (5) we have to consider the possibility of the aspiration of infectious material into the alveoli of the lungs.

Operative pneumonia has been reported with the following frequency:

	Operation.	Pneumonia.	Mortality.
Anders	57,842	46	
Hewitt	2910	3	
Rumboll	1500	6	
Gurit	52,177	30	
Derjuskinsky	4946	43	0.4%
Kuemmell	1017	40	28
Henle	1787	143	65
Bibergeil	3909	135	
Schultze	5724	27	
Kelly	1800	8	
Rothrock	489	5	3
Silk	5000	13	
Gebele	1196	77	53
Total	140,397	570	(0.4%) (Mortality 45%)

Anyone, I think, who has the courage to try the fresh-air treatment, and sufficient persuasive power over the patient's relatives to allow it to be tried, will, I am convinced, never abandon it, even though the future may bring us a specific for pneumonia in the form of a curative serum. Of course, it takes time to eradicate prejudices and to change beliefs. It has not been so very long since patients with tuberculosis were advised to spend their time in closed rooms before a stove. It is an even shorter time since pneumonia patients were swathed in poultices, enveloped in jackets, and kept in rooms in which even the windows and doors were made as air-exclusive as possible by stuffing cotton into the cracks. We have gradually dispelled the fear of cold sponging and bathing in typhoid fever, and we will in time abate the dread of fresh air in pneumonia.

I shall never forget a big negro, in the third day of his pneumonia, whom I saw in the general medical ward, restless, fevered, and panting, the typical picture of the anguish which one so often sees in these cases. An hour later I saw him in the pneumonia ward whither he had been promptly transferred. It was a cold day in March, the windows and the door were wide open, so that there was a constant current of fresh cold air blowing over the beds. The patient greeted me with a smile, displaying a fine line of teeth which contrasted strikingly with his Ethiopian blackness, and remarked, "Fo de Lawd, Doc, I feels lak anoder man down hyar." This is not an isolated or exceptional incident, numbers of patients desperately ill have told me, upon inquiry, that they felt "pretty good." If then we can show not only an increased *bien faisançe* on the part of the patient, but also a reduced mortality, and an absence of deleterious effects why should not this method of treatment be the usual instead of the exceptional one?

THE PHARMACOLOGY OF HEART STIMULANTS.[1]

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A subject so broad as that covered by the title of this paper cannot be considered within a reasonable limit of time, and I shall therefore confine my remarks to those drugs which are classed together as the digitalis group, and to those pharmacological points which are of interest especially to the medical therapeutist. In discussing this subject I shall consider first one or two noteworthy facts common to the whole group, and, then, the points of individual difference of its more important members.

There are three essential factors in the action of these drugs which interest clinicians: (1) The stimulant influence upon the cardio-inhibitory mechanism which prolongs the diastole and thus slows the pulse; (2) the increase in the tonicity of the heart muscle leading to a more complete and more powerful systole; and (3) the constriction of the bloodvessels. The dicrotism, the incomplete diastole, and the incöordination of the heart, which are produced by very large doses of digitalis, are toxic manifestations and of minor importance to the therapeutist.

The action of digitalis in slowing the pulse is, I believe, a much more important factor in its beneficial influence in heart disease than is generally deemed. It is evident that if the quantity of blood thrown out by the heart at each contraction were constant, then the more slowly the heart beat the less blood would be pumped in a given time; in other words, if the volume of the pulse remained the same the rate of the pulse would be an accurate criterion of the work performed, and an inhibitory stimulation would mean less work done by the heart and consequent reduction in the blood pressure. But the volume of blood expelled at each contraction does not remain the same. The longer the diastole, within reasonable limits, the larger is the volume of the pulse wave. It has been shown experimentally by Elving and Wendt[2] and others that there is a degree of compensatory correlation between the rate and the volume of the pulse so that the amount of blood pumped by the heart per minute tends to remain constant despite variations in its rate.

The mechanism of this arrangement is not difficult to apprehend if we remember that the slowing of the pulse depends chiefly upon the prolongation of diastole. The lengthening of the period of auricular relaxation allows more blood to flow from the great veins

[1] Read at the meeting of the American Therapeutic Society, Philadelphia, May 7, 1908.
[2] Skand. Arch. f. Physiol., 1907, xix, p. 96.

into the auricle, either of the right or left heart as the case may be; and the prolongation of the ventricular diastole permits the auricle completely to empty its contents into the ventricle, so that when that chamber begins to contract it finds itself well filled with blood, and consequently the pulse volume is increased. Although according to the experiments quoted the increased volume is ordinarily not sufficient entirely to compensate for the diminution in the pulse rate which results from stimulation of cardiac inhibition and the amount of blood per minute pumped may be somewhat lessened, nevertheless, it seems to me that the heart beating at a slow rate is working more economically than the rapidly acting organ.

If the ventricle begins to contract at a time when it is only half filled with blood, half of the effort of contracting is wasted in reducing the size of the chamber to correspond to the small amount of blood which is within it. On the other hand, if the ventricle is completely filled with blood before it begins to contract it is evident that all of the shortening of the cardiac muscle fiber which takes place does useful work; therefore the bigger the pulse volume the more work does the heart accomplish with the same expense to its total power, and consequently the more slowly the heart acts the more sparing is it of its reserve energy, and it obtains as well a longer period for rest and reconstruction.

In cases of chronic heart disease, when it is essential to make the burden thrown upon the feeble heart as light as possible, it appears to me highly important that we do what we can to slow the pulse, and the inhibitory stimulation of digitalis becomes *the* beneficial factor in its effects. The mere stimulation of the heart muscle is a matter of minor importance. What necessity is there for, or advantage derived from, the elevation of blood pressure? Dyspnœa, local congestion, or œdema may be temporarily relieved by other heart stimulants, as caffeine or ammonia; but is the patient any farther from the grave because some local evidence of heart weakness is concealed?

The objection has been raised against this view, that inhibitory stimulation tends to a relaxation of the muscle which might encourage a further dilatation of a weak cardiac wall, but here the action of digitalis in increasing the tonicity of the heart muscle comes into prominence as a preventive of this danger.

The only one phase of the effect of digitalis in increasing the muscular vigor of the heart, which I think needs emphasis at this time, is that in no other portion of the heart is the influence of the drug felt in the same way as it is in the left ventricle. Although the observation of Kaufmann that the disatolic, as well as the systolic, pressure in the left ventricle is augmented by digitalis indicates that the force of the auricular systole is to an extent increased by digitalis, yet it is a common occurrence to see the ventricle of the frog's heart firmly contracted in systolic spasm, while the dilated

engorged auricles are making ineffectual efforts to force blood into the larger cavity.

This fact becomes of importance in certain cases of mitral regurgitation when the ventricular muscle has undergone a larger degree of hypertrophy than has the auricle. Under the influence of digitalis the ventricle may drive the blood backward through the leaky mitral valve so vigorously as to overcome the muscular resistance of the feeble auricle and lead to further dilatation of that part of the heart. Moreover, in these cases the second defense, the right ventricle, will likely prove insufficient, for the experiments of Bayet[3] as well as my own studies[4] have shown that the action of the drug upon the right heart is comparatively insignificant.

There remains of the physiological actions of digitalis to be considered, its vasoconstricting influence. This action has frequently been regarded as a harmful by-effect to be avoided or combated, a point of view which I believe has at times led practitioners to adopt irrational or even injurious measures.

It is of course true that it requires more force to drive the blood through narrow arteries than it does through dilated ones, but it is equally true that in many cases the vascular contraction is a conservative effort on the part of nature to maintain the circulatory equilibrium. The coronary arteries are comparatively small vessels springing at right angles from a large trunk, a condition which is in many ways unfavorable for the entrance of blood into them. It is evident, therefore, that a considerable degree of pressure in the aorta is an absolute requisite for good coronary circulation. Tigerstedt and Johansson[5] have shown that in states of very low arterial tension despite the diminished resistance in front of it the ventricle may be unable to empty itself as completely as normally, a phenomenon most rationally attributed to lessened heart power the result of insufficient nutrition.

I do not mean to infer that the vascular effects of these remedies is never detrimental. There is scarcely room for doubt that when, as a result of degenerative changes in the muscle or an extreme degree of dilatation, the muscular tissue of the ventricle is too scanty to respond properly to the tonic influence of digitalis, the increased resistance to the flow of blood may work great damage. But I do think that these cases are much less frequent than is generally believed. Clinicians should not be too hasty in their efforts to dilate the vessels in cases of chronic heart disease; especially so since almost the only agents which we possess for this purpose, the nitrites, are substances which increase the rate of the pulse and must therefore tend to counteract the beneficial influence of digitalis in slowing the heart. The only reason that more harm has not been accomplished by the

[3] Acad. Royale de Med. Belg., 1892.
[4] Amer. Jour. Physiology, 1902, vi, p. 283.
[5] Skand. Arch. f. Physiol., 1891, ii, p. 409.

use of nitroglycerin in heart disease is because the method in which it is habitually given precludes any possibility of its having serious influence upon the circulation. The effects of a single dose of nitroglycerin last on an average about three-quarters of an hour, or, perhaps, under favorable conditions, an hour. How great is the folly, therefore, to administer it three times in the twenty-four hours and expect any permanent result.

I now come to the consideration of the differences in the effects of the individual members of this group of remedies. The digitalis drugs which are used practically are digitalis, strophanthus, squills, apocynum, and adonidin.

Squills and apocynum, on account of their irritant action upon the gastro-intestinal tract and upon the kidneys, are of practical utility only in selected cases, so that I shall dismiss them without further consideration.

There is a widespread belief that strophanthus differs essentially from digitalis in that it exercises little or no influence upon the bloodvessels; a belief for whose truth I have sought in vain for any convincing scientific evidence. This much, at least, has been clearly demonstrated by the work of Gottlieb and Magnus[6] and more recently by Tigerstedt,[7] that the action of strophanthus upon the vessels is a very marked one and even if it be a less powerful influence than that of digitalis, the difference is comparatively slight. There is, however, one important distinction between the action of these drugs, namely, that strophanthus is less likely to give rise to cumulative toxic symptoms than is digitalis, a fact of general clinical experience which has been experimentally confirmed by Fraenkel.[8]

Of adonidin our knowledge is far from satisfactory. It seems well established that its effect on the heart muscle and on cardiac inhibition are similar in kind, if somewhat less powerful in degree, than those of digitalis. On the other hand, Kakowski[9] found that whereas strophanthus and digitalis both constricted the coronary arteries adonidin widened them, a suggestive observation the precise bearing of which in our present state of ignorance is not clear. It is a remedy of promise, but, although it has now been before the profession for nearly thirty years, it remains still in the stage of promise.

In cases of chronic heart weakness, when merely the cardiac action of this group is desired, digitalis itself yet stands supreme. I wish, however, to say a few words concerning the search for the active principle of this drug, or for a substance which would represent its therapeutic virtues in small bulk. Moved by a desire partly for scientific accuracy in dosage, partly for a convenient form

[6] Arch. f. Exper. Path. u. Pharm., 1901, xlvii, p. 135.
[7] Skand. Arch. f. Physiol., 1907, xx, p. 115.
[8] Arch. f. Exper. Path. u. Pharm., li, p. 84.
[9] Arch. Internat. de Pharmacodyn. et Therap. xv, p. 21.

of administration, and partly by the love of the novel, clinicians have from time to time experimented on their patients with various of the glucosides which have been found in the digitalis leaves. At present digitoxin holds the foreground among these substances; but this much is clear, that if there be any single principle which represents completely the therapeutic virtues of digitalis that principle is *not* digitoxin. In the first place Fraenkel has shown that of all the digitalis glucosides digitoxin is the most dangerous and the most cumulative in its action; secondly, the work of Gottlieb and Magnus would indicate that digitoxin is decidedly more active in its vasomotor effects than either digitalis itself or strophanthus; and, thirdly, Kakowski experimenting with digitalin, digitalein, and digitoxin, was able with none of them to produce the increase in the contracting power of the heart that is brought about by digitalis.

ATAXIA OF THE HEART MUSCLE.

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Since the simultaneous graphic registration of venous and arterial pulses has been generally adopted, following the pioneer work of Mackenzie,[1] we have learned that dissociations in the activity of the different heart chambers occur very much more frequently than we formerly supposed. The dissociation of auricular and ventricular contractions has been generally accepted since the publications of His, Mackenzie, and many other writers. The anatomical cause has been shown to consist in a lesion of the bundle of His, reproduced experimentally by Hering[2] and Erlanger[3] and shown pathologically by Stengel,[4] and Ophuls and myself.[5]

Only lately the discussion of the possibility of hemisystole, an isolated contraction of one side of the heart, while the other remained in diastole, has been taben up.

Twenty years ago von Leyden[6] reported several cases in which he tried to explain by a hemisystole the phenomena observed in cases o mitral disease. In those cases two apex beats and two pulsations of the jugular vein corresponded to one arterial pulse; the first apex beat with a corresponding arterial and venous wave was supposed to correspond to a complete contraction of both heart chambers; while the second apex beat with a venous wave, but without an

[1] Study of the Pulse.
[2] Jour. of Exper. Med., 1906.
[3] Deut. Arch. f. klin. Med., vol. lxxxvii.
[4] Pflüger's Archiv., 1905, cviii.
[5] Amer. Jour. Med. Sci., 1905.
[6] Ztschr. f. klin. Med., vol. lxiv.

arterial pulse, was thought to correspond to an isolated contraction of the right ventricle.

This view advocated by von Leyden and defended again recently, has not been generally accepted. Riegel especially tried to show that the phenomena could be more easily explained by the theory that the second beat corresponded to a premature contraction of the whole heart, and that the absence of the arterial pulse could be explained by the fact that the left ventricle during the short diastole had not recovered sufficient strength to overcome the arterial pressure and open the aortic valve. This view has been generally adopted, and by the work of Wenckebach, Hering, Cushny, and Mackenzie has been shown to be the cause of the supposed hemisystole in the great majority of cases.

The possibility of a hemisystole has been denied on physiological and anatomical grounds, especially by Hering who admitted the occurrence of hemisystole only as a symptom of agony in a dying heart. Notwithstanding the authority of such an excellent observer as Hering, the occurrence of hemisystole has been very widely discussed in recent years.

It was again Mackenzie who first published some tracings in which there was an incongruence in the number of apex beats, indicating the action of the left ventricle, and the number of venous pulsations. He considered these tracings as very exceptional, and admitted the incongruence of the left and right heart action to be a symptom of beginning death.

The question of hemisystole was taken up again by F. Kraus and G. Nicolai,[7] who published a preliminary communication on this question. They studied the question by the graphic method in the perfused heart and by the electrodiagram in the human heart, and reached the following conclusions: If ventricular extrasystole is produced by direct stimulation, the ventricle in which the extra stimulus is produced contracts more strongly than the ventricle to which the stimulus has to be transmitted. If one diminishes the intensity of the stimulus, the contraction of the second ventricle becomes weaker, until a point is reached at which the first ventricle contracts, while the second one does not register any change in the intraventricular pressure. Such conditions arise in the human heart, if the extrasystole proceeds from the left ventricle. Here all the variations may be observed, deviation in the strength of the contraction and deviation from the synchronism of the contraction, until complete hemisystole occurs.

A second method by which the occurrence of hemisystole could be shown consisted in the electrocardiogram taken by Einthoven's method. Krause and Nicolai assert that the electrocardiograms of the left and the right ventricle are different from each other and

[7] Deut. med. Woch., 1908, p. 1.

are characteristic of the contraction of either left or right heart. The electrocardiogram taken over the heart during a ventricular extrasystole shows by variations in its form the part which the left and the right ventricle are playing. The form of the electrocardiogram also indicates the point from which the extrasystole starts, whether from the left or from the right ventricle. In some cases the electrocardiogram assumes the form of a purely right-sided cardiogram; under those conditions a hemisystole of the right ventricle may be diagnosticated.

The views expressed by Krause and Nicolai and the arguments for their validity cannot be judged at the present date, as the experimental evidence for their conclusions is not fully published, and as the value of the electrocardiogram, its interpretation, and especially the differentiation of the left and the right ventricular curves are not fully established and accepted.

Recently Wenckebach[8] has reported a case in which he was able to show the existence of dissociation in the activity of the ventricles. He drew attention to the fact that in cases of perpetual arrhythmia the disappearance of murmurs in extrasystoles points to the fact that not the whole ventricle is contracting, but only certain parts of it. The same conclusion can be reached by the fact that the height of the pulse does not depend upon the length of the preceding diastole, as under normal conditions. In several tracings of the apex beat obtained in a case of perpetual arrhythmia a superposition of three systoles could be demonstrated, each following systole beginning before the preceding had ended. As during systole the heart muscle is refractory to any stimulus, the conclusion had to be reached that the second systole began in a part of the heart muscle which had not contracted during the preceding systole. The case, therefore, proves the existence of partial contractions of the ventricle. Similar dissociations in the activity of the two auricles and the venous sinus were reported in the same exceedingly interesting paper of Wenckebach.

According to modern literature, therefore, we must distinguish between two varieties of dissociation of the activity of the ventricles: (1) Hemisystole consisting of alternating contractions of the left and the right chambers of the heart; and (2) partial contractions of the heart muscle, for which I propose the name of "ataxia of the heart."

Dissociation of the activity of the ventricles seems to be very rare, as very few convincing observations of this condition have been published. I have encountered it only once amongst a very great number of tracings obtained from heart cases. As the condition may be of some interest I shall briefly describe the phenomena observed in the patient:

[8] Archiv f. Anat. and Phys., Phys. Abteil.

E. B., aged twenty-seven years, Italian, entered the hospital on November 29, 1907, complaining of swelling of the legs, shortness of breath, cough, and pain over his heart. He had rheumatism about seven years ago in his right knee, incapacitating him for about three or four days, but otherwise he has never been ill. In April, 1907, he had a first attack of insufficiency of the heart with shortness of breath and cough lasting for about two months; lately these symptoms have returned, aggravated by marked sleeplessness and pain of an anginoid character. In the last few weeks he has noticed swelling of the legs.

On admission the patient presented the picture characteristic of combined failure of the left and right ventricles. His skin was extremely pale and seemingly exsanguinated, spotted at the ear, cheeks, and lips by deeply cyanotic areas; there was quite an appreciable amount of œdema extending to the knees. The respiration was quite labored, varying between 30 and 40 per minute. The pulse was very irregular in force and rhythm; comparing it with the apex beat one could easily notice that a large number of heart beats did not reach the wrist. The veins of the neck were markedly distended and pulsated. The apex beat could be felt, very heaving in character, in the seventh interspace in the anterior axillary line; the right heart border was 2 cm. to the right of the right sternal border, the upper border at the third rib. Over the whole area of the heart a systolic thrill could be felt. On auscultation such a multiplicity of murmurs were heard, that it was at first impossible to come to a clear conception of the valvular lesions. After the heart had slowed down under the influence of digitalis, a long drawn-out systolic murmur was audible at the apex, preceded by the sharply clicking sound of mitral stenosis. The second sound was very indistinct, and was followed by a long drawn-out diastolic murmur extending to the beginning of next systole. Over the tricuspid area a systolic murmur could be heard, while at the aortic area a sharp systolic murmur was present and was carried through the aorta up to the arteries of the neck. The diastolic sound over the aorta was normal, while distinctly accentuated and reduplicated over the pulmonary artery. The liver was distinctly enlarged, extending 5 cm. below the costal margin, and was easily palpable. Pulsation of the liver, however, could not be made out. The urine was very scanty and contained a small amount of albumin.

The diagnosis was made of aortic stenosis, mitral insufficiency and stenosis, and tricuspid insufficiency.

Under large doses of digitalis the heart regained sufficient strength, the œdema, the cyanosis, and the albumin in the urine disappeared. Three days after beginning the digitalis medication the pulse frequency fell below 60; digitalis was stopped, but the frequency of the pulse kept on falling until on the fifth day it fell to 28; comparison

with the apex showed that each radial pulse corresponded to a bigeminal heart beat, of which the second was abortive.

The patient made an uneventful recovery. The tricuspid murmur disappeared with the slowing of the pulse. Six weeks afterward the patient left the hospital with a heart sufficiently compensated for light work.

At the beginning of January the patient returned for treatment, with almost the same condition that prevailed when he first entered the hospital. He reacted again very nicely to digitalis medication; under small continued doses of digitalis the heart has kept in good condition ever since.

Certain auscultatory phenomena at the time of the first examination attracted our attention to the possibility of dissociation between the action of the two ventricles. During the first few days the heart action was so rapid that no definite inferences could be drawn; as the heart began to slow down, however, it appeared that a certain number of the beats not leading to a radial pulse were distinctly different from the normal systoles and produced auscultatory phenomena very different from the usual cardiac sounds. While in successful contractions the first sound started with a clicking sound, indicative of mitral stenosis, in other contractions only a very soft systolic murmur could be heard followed by a normal second sound. The absence of the clicking sound seemed to show that the mitral orifice did not close and that, therefore, the left ventricle during certain phases of the heart action did not contract. Occasionally another modification of the heart sounds was observed: It seemed as if both the first and the second sound started an echo; the first sound was followed by another sound too far separated to be taken for a simple reduplication; then a second sound could be heard followed by another second sound.

Both these phenomena seemed to point to dissociation between the action of the right and the left ventricle; tracings taken at that time corroborated this view. Under the influence of digitalis these auscultatory signs disappeared entirely; the right and the left heart seemed to work together. Later on the dissociation recurred, but without any auscultatory signs indicating a dissociation. The most painstaking auscultations of the heart did not reveal any sounds, while the jugular vein still kept on pulsating.

A great number of tracings were taken during the four months the patient was under observation. The difficulty in arriving at an understanding of the waves present in the tracings obtained called for further observations; but at no time except at the time of the acute digitalis poisoning, could anything be obtained resembling a normal phlebogram.

Figs. 1, 2 and 3 are parts of tracings selected as best illustrating the condition constantly found. Fig. 1 was taken at slow speed, Figs. 2 and 3 at high speed, as may be seen from the markings corresponding to $\frac{1}{5}$ seconds.

Fig. 1, taken at slow speed, demonstrates the impossibility of finding a definite relation between the arterial pulse and the jugular pulse. The heart is beating irregularly but slowly, as can be seen from the tracing of the apex beat; the radial pulse corresponds in

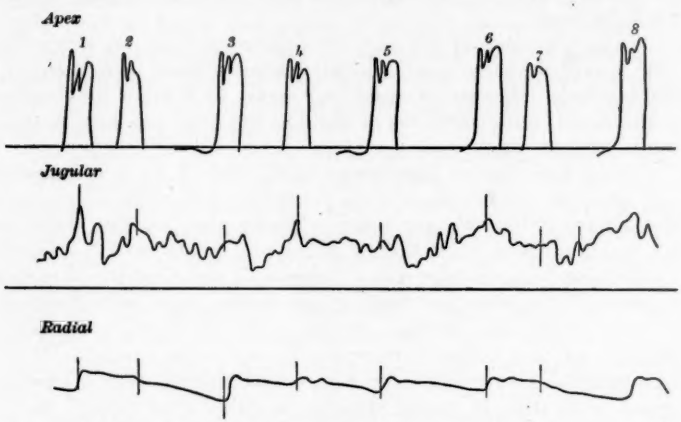

Fig. 1.—Taken at slow speed; the marks indicate the beginning of cystole in the radial artery and the corresponding point in the venous pulse.

frequency to the apex beat. If two heart beats follow each other quickly, as systole 1 and 2, the radial pulse corresponding to the second beat becomes very small and is considerably retarded compared to normal beats. This is another illustration of the Extra-

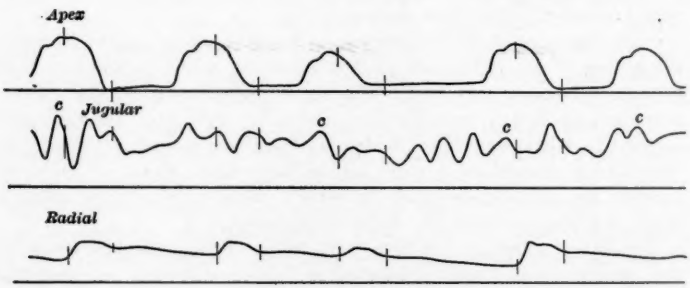

Fig. 2.—The same as Fig. 1, but at high speed.

verspätung described by Hering, due to the occurrence of premature beats. The heart muscle, which has not recovered sufficient strength in the short diastole, opens the aortic valves at a later period of the systole; the extra wave travels in the arterial system not as quickly as a normal wave, for reasons sufficiently discussed by Hering.

If one tries to analyze the venous pulse occurring between one apex and radial beat and the next, one is impressed by the number of waves corresponding to one heart evolution. In systole 2 there are seven waves occurring between radial beat 2 and 3; in systole 5 there are ten waves. Similar conditions prevail in Figs. 2 and 3, taken at high speed. In systole 3 of Fig. 3 there are five waves corresponding to one radial pulse.

The interpretation of the venous pulse offers great difficulties, since the normal waves of the venous pulse cannot be identified. In Fig. 3 corresponding points are marked, the first mark of each systole corresponding to the beginning of the radial pulse; the second mark shows the beginning of diastole indicated by the dicrotic wave. While the points on the apex beat and radial tracings correspond very nicely in the different systoles, no relation can be found between

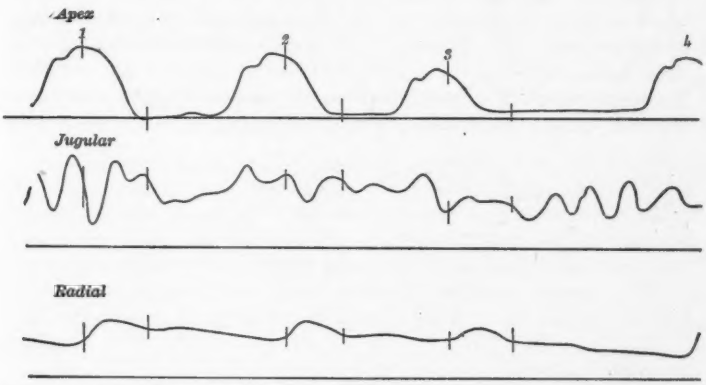

FIG. 3.—Taken at high speed; shows in systole 3, 5 venous waves corresponding to one arterial pulsation.

the waves of the venous pulse and the radial pulse. Sometimes the *c* wave corresponds to a very sharp wave, sometimes to a very slow wave, sometimes to a depression. In Fig. 3, systole 3, a diastolic wave is entirely missing, showing that the diastole of the right ventricle did not occur at the same time as the diastole of the left, thus proving the dissociation in the action of the two ventricles.

The explanation of the venous waves occurring during the diastole of the left ventricle is very difficult. Waves occurring during diastole known so far are: (1) The *v* wave occurring synchronously with the beginning of diastole. (2) The wave *a* produced by the contraction of the right auricle preceding ventricular systole. (3) Lately, A. Hirschfelder[9] has drawn attention to a wave *h* occurring

[9] Johns Hopkins Hosp. Bull., vol. xviii.

in diastole and caused, according to his interpretation, by the closure of the mitral valve. Gibson later described the same wave and connected it with a third heart sound which occasionally may be heard in a slowly beating heart. Einthoven has encountered the same wave in his electrodiagrams.

Four waves, therefore, may correspond to one arterial pulse: The *a* wave corresponding to auricular systole; the *c* wave due partly to the transmitted carotid wave, and partly to a systolic venous wave; the *v* wave setting in at the beginning of diastole; and the *h* wave occurring in full diastole, and the cause of which is still under discussion.

To one evolution of the left ventricle only four venous waves can possibly correspond. The recurrence of seven to ten waves during one arterial pulse can be explained in one of the following ways: (1) In case the waves are caused by contraction of the auricle, (*a*) by block between the auricle and the ventricle, and (*b*) by fibrillations of the auricles. (2) In case the waves are ventricular in origin, by dissociation between the action of different parts of the ventricle. To decide which of these explanations should be adopted, tracings of the heart action were taken from the œsophagus; at the same time

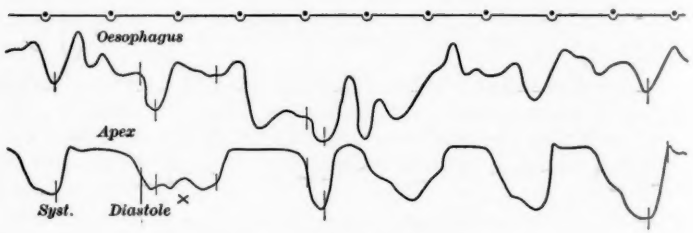

FIG. 4.—Œsophageal cardiogram.

the apex beat was registered (Fig. 4). To understand the meaning of this tracing I must discuss the meaning of the normal œsophageal cardiogram, the explanation of which we owe to Rantenberg[10] and Hewlett.[11] Fig. 5 is taken from Rantenberg's work. The wave preceding the apex beat is evidently due to the action of the left auricle as *s;* at the beginning of the ventricular systole the œsophageal tracing also shows a raising line *vs*, followed by several secondary waves, until the beginning of diastole is indicated by a sudden sharp fall *D*. At this moment the diastole begins and the mitral valves open; the left auricle which is in contact with the registering apparatus suddenly collapses, leading necessarily to a sudden fall of the tracing.

[10] Archiv. f. klin. Med., 1907, xci.
[11] Jour. Med. Research, 1907, xi.

These points, applied to the interpretations of the œsophageal tracing obtained in my case, show that the œsophageal registration concords absolutely with the cardiogram. The number of beats registered corresponds with the number of apex beats, and not with the venous tracings. On the other hand, no trace of auricular contraction could be obtained, proving that in this case the irregular heart action was complicated by auricular paralysis, as was to be expected in a case of perpetual irregularity.

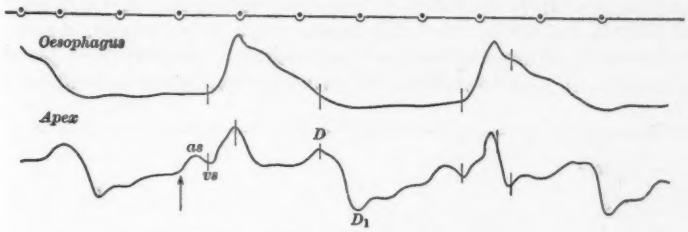

FIG. 5.—Normal œsophageal cardiogram.

On the other hand, the absence of auricular waves proves that the right auricle was paralysed. We know from the work of Fredericq and Erlanger,[12] that the left auricle is almost invariably dependent upon the right auricle for its activity. Fibrillation of the right auricle with complete paralysis of the left auricle has never been observed, as far as I have been able to learn; the same reason also excludes the possibility of block between the auricle and the ventricle.

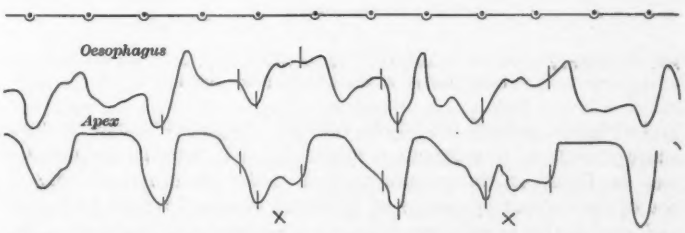

FIG. 6.—Showing partial contractions of the left ventricle at the points marked by ×.

I am, therefore, obliged to assume that the multiplicity of the venous waves is due to dissociation in the action of the right and the left ventricle.

The mechanism of this dissociation is shown by the œsophageal tracing. In Fig. 6 two parts of the œsophageal tracings, together

[12] Amer. Jour. Physol., xix. 125.

with the corresponding apex beats, are reproduced. In the places marked by *X*, there are three instances in which both apex and œsophageal tracing differ quite distinctly from the other parts of the tracing. In both, following the fall which marks the beginning of diastole, there is a new ascending wave, corresponding in the apex tracing to a beat very much smaller in size than the usual apex beat. In the œsophageal tracing the wave due to this contraction seems to be slightly smaller than the usual wave: the principal difference from the ordinary beat, however, is due to the fact that the next beat begins before the fall of the curve indicating that the beginning of diastole has set in. In other words, the next contraction begins before the previous contraction has finished. This can take place in two ways: (1) In the form of partial contraction of the ventricle;

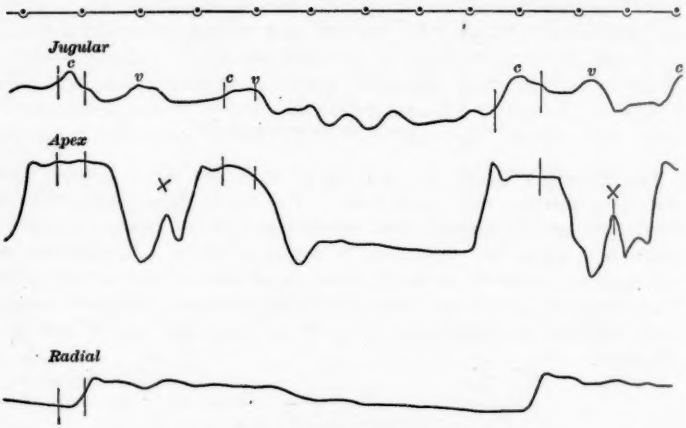

FIG. 7.—Showing at the points marked × partial contractions of the left ventricle interrupted before diastole by a complete systole.

that only one part of the whole ventricle responds to one stimulus, another part to a subsequent stimulus. (2) Another explanation may be found in the possibility that under certain conditions the law of the refractory period of the heart muscle does not hold good, and that under certain conditions a superimposed contraction may occur in the already contracting ventricle.

While the second view may be discussed, in view of the work of Rhode and Carlson, showing that under certain conditions the heart in systole is not absolutely refractory to new stimuli, such a supposition would not be justifiable in view of Fig. 3, which shows an absolute incongruence in the work of the right and the left ventricle. We, therefore, have to admit as an explanation the occurrence of partial contractions of the ventricles. It has to be conceded that such partial contractions do not occur only in the right ventricle; the

œsophageal tracings showed that similar partial contractions occurred also in the left ventricle. Fig. 7 shows also at the point *X* a partial contraction interrupted before its diastole by the following full-sized diastole.

I have already proposed the name of ataxia of the heart muscle for the phenomenon of partial ventricle contractions. As in locomotor ataxia the coördination of the different parts of the muscles of the limbs has been lost, so in ataxia of the heart the coöperation of the different parts of the heart muscle is lost. How the circulation can be kept up effectively under such conditions is a marvel to anybody who has carefully analyzed the action of such a heart. Evidently the partial contractions do not influence the blood stream which is entirely kept up by the full-sized contraction.

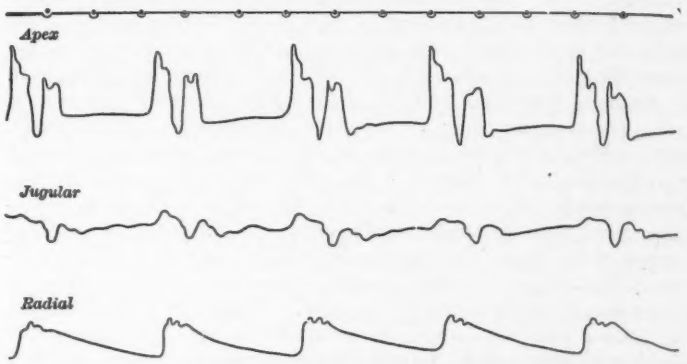

FIG. 8.—Showing typical digitalis action with normal phlebogram of ventricular type without any partial contractions.

The explanation of the phenomenon of ataxia is very difficult. One could at first think that the stimulus originating at the auriculoventricular ring is blocked in different places and reaches different places of the ventricle at different times. Such an explanation is impossible in view of the fact that the ataxia of the heart disappeared under digitalis (Fig. 8). Digitalis slows conduction and would aggravate any condition due to a lesion of conductivity. I believe the phenomenon to be due to different parts of the heart originating their own rhythm, as shown in Erlanger's experiments, in which every part of the heart muscle, even if separated from the region of the large veins or the His bundle, contracted rhythmically.

Investigation of ataxia of the heart will certainly show that partial contractions of the ventricle occur quite frequently in perpetual arrhythmias, and that a large number of symptoms observed in these cases can be explained only by partial contractions of the ventricles.

THE INTERPRETATION OF THE VENOUS PULSE.[1]

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(From the Laboratories of the Jefferson Medical College Hospital, Philadelphia.)

The knowledge of the existence of pulsations in the veins dates back to 1704 when Homberg[2] presented to the French Academy the result of his observations on the venous pulse. Morgagni,[3] however, was the first to offer rational views concerning this phenomenon. His dissertation upon the venous pulse is to be found in his work, *De sedibis et causis morborum*, which appeared in Venice in 1762. The first attempts to study the venous pulse experimentally were made by Barry[4] in 1826 and by Wedemeyer[5] in 1828, but owing to the inadequate methods used, their results were rather unsatisfactory. Bamberger[6] in 1856, and others following him, in common with their clinical predecessors, described the venous pulse as occurring only in tricuspid insufficiency. Bamberger, later (1863) published tracings of the venous pulse of tricuspid regurgitation, while Marey[7] in the same year took graphic records from animals. Friedreich,[8] in 1865, showed its presence in conditions other than tricuspid insufficiency, and described it as being formed of two waves: one presystolic in time and due to the contraction of the auricle, the other systolic in time and due to the shock of the aorta against the superior vena cava. Potain,[9] in 1868, described the venous pulse as composed essentially of a positive wave, due to the auricular systole, followed by two negative waves, the first being caused by the auricular, the second by the ventricular diastole. The same observer, in 1881, published tracings taken simultaneously from the jugular vein, and either the carotid artery or the cardiac apex. In the same year Riegel[10] interpreted the normal venous

[1] Read by invitation at a meeting of the Pathological Society of Philadelphia, April 9, 1908.

[2] Sur un battement de veines semblable au battement des artères. Hist. acad. roy. d. sc., Paris, 1704. Amst. 1707, 218 to 223. Also, Rec. d. mem., Dijon, 1754, ii, 138 to 140.

[3] De sedibis et causis morborum, Venice, 1762. Letter XVIII, Sec. 9, 10, 11.

[4] Recherches expérimentales sur les causes du mouvement du sang dans les veines. Mem. Acad. d. Sc., Paris, June 8, 1825. Paris, chez Crevot, 1825. Experimental researches on the Influence of Atmospherical Pressure upon the Progression of the Blood in the Veins, etc., London, T. and G. Underwood, 1826.

[5] Untersuchungen über den Kreislauf des Blutes und insbesondere über die Bewegung desselben in den Arterien und Capillargefässen, Hanover, 1828.

[6] Lehrbuch der Krankheiten des Herzens, 1857. Beobachtungen über den Venenpuls. Würzb. med. Ztschr., 1863, iv, 232.

[7] Physiologie méd. de la circulation du sang, 1863.

[8] Ueber den Venenpuls. Deut. Arch. f klin. Med., 1865 to 1866, i, 241.

[9] Des mouvements et des bruits qui se passent dans les veines jugulaires Mem. soc. med. hop. de Paris, 1867 and 1868.

[10] Ueber den normalen u. pathologischen Venenpuls. Deut. Arch. f. klin. Med., 1882, xxxi, 1. Experiment. Untersuchungen über den normalen Venenpuls, Deut. Arch. f. klin. Med., xxxi, 470.

pulse very much as Friedreich had before him, believing, however, that the principal wave was that originating in the contraction of the auricle.

Since that time most of the descriptions given in text-books on diagnosis, have embraced two forms of venous pulse: (1) The physiological venous pulse, characterized by a presystolic positive wave attributed to the arrest or slowing of the flow of the blood in the veins as a result of the auricular contraction; since this wave is immediately followed by a negative wave synchronous with the arterial pulse, this form of venous pulse is sometimes called systolic venous collapse; (2) the pathological or centrifugal regurgitant venous pulse consisting of a systolic positive wave due to a regurgitation of the blood into the auricle, and, possibly, also into the veins during ventricular systole and characteristic of tricuspid insufficiency, whether it be organic or functional.

François Franck[11] and later Fredericq,[12] showed that in the absence of tricuspid regurgitation a slight systolic wave is constantly present in the jugular veins of animals. Franck attributed the formation of this wave to the shock of closure of the auriculoventricular valves, while Fredericq believed it to be due to the sudden projection of these valves into the auricle at the beginning of ventricular systole. They both interpreted the presystolic wave as their predecessors had: as caused by the auricular systole. They also called attention to a third wave occurring at the end of ventricular systole. François Franck ascribed it to the sudden lowering of the base of the heart at this phase of its cycle. Fredericq assigned its cause to the sudden diminution in volume of the auricle occurring when its walls return to their position of rest.

To Mackenzie[13] belongs the credit of having attracted the attention of clinicians to this third wave, which had escaped their notice until his excellent work, *The Study of the Pulse*, appeared.

The apparatus used to obtain the tracings shown in this article consists of two Marey tambours provided with long levers made of very thin, light straw, the writing points being short and thin strips of aluminum. The pulsations were taken up by means of Mackenzie's capsule, or by means of a small glass funnel, according as the one or the other gave the better results. So far as the venous pulsation is concerned, Mackenzie's capsule with a flat side which can be laid against the clavicle, is best adapted for the purpose. Needless to say, the rubber tubes leading from the receivers (capsules

[11] Mouvements des veines du cou en rapport, etc. Gaz. hebd. med. et chir., Mars et Avril, 1882. Nouvelles recherches sur un cas d'ectopie cardiaque pour servir a l'étude du pouls jugulaire, Arch. de phys., 1889, i, p. 70.

[12] Sur le pouls veineux physiologique, Travaux du laboratoire, 1889 to 1890, t. iii, p. 85. La pulsation du coeur chez le chien. Arch. de biologie, 1890, x.

[13] The Significance of the Venous Pulse. Edinb. Med. Jour., 1894. The Study of the Pulse and Movements of the Heart, London, Macmillan, 1903. The Interpretation of the Pulsations in the Jugular Veins. AMER. JOUR. MED. SCI. 1907, cxxxiv, 12.

or glass funnels) to the tambours were exactly of the same length. Especial care was also taken before each observation to see that the writing points fell exactly on the same perpendicular line. The kymograph, on which the records were made, is the latest model of the Harvard kymograph, the speed of which can readily be varied to suit each particular case. The time record was obtained by means of a Page vibrator, the reed of which vibrated fifty times a second.

The superiority of such an arrangement is obvious when one compares the results here presented with the tracings taken with even the best of the small sphygmographs. The clockwork of the latter instruments is often too slow to permit of an accurate estimation of slight differences of synchronism between two curves, a point which is not without importance, as we shall see later.

The venous pulsation was taken from the point at the root of the neck which gave the best excursion of the lever. In the great majority of instances this point is to be found on the right side, although in a certain number of cases the venous pulse is more marked on the left side. The best pulsating point is often over the position of the jugular bulb, but it is by no means rare that a better jugular pulse can be recorded when the receiver is placed over the lower part of the external jugular vein. Finally the patient was placed in the recumbent posture, for in many cases the jugular pulse disappears when the patient assumes a posture in which the trunk is erect. As dyspnœa is a disturbing factor, whenever this was present the patient was asked to breathe as quietly as possible.

For the purpose of timing the various events in the complete cycle of a jugular pulsation, a simultaneous record of an arterial pulse or of the heart beat is indispensable. The carotid pulse was, therefore, taken simultaneously with the jugular pulse, and in all those cases in which it was possible a record of the heart beat was also taken simultaneously with the jugular pulsation. In order to establish points of synchronism in the two curves, ordinates were drawn with the levers while they were still in the position they occupied during the time the tracing was being taken.

In Fig. 1 the complete cycle of a jugular pulsation is seen to consist of three positive waves, the first two of which, *a* and *s*, are relatively of short duration and have a sharp summit, while the third wave, *v*, is of longer duration and has a broad summit divided by a notch so that it presents a bifid appearance. These positive waves are separated by three depressions, or negative waves. The first two (2 and *Af*) are abrupt and occupy little time, while the third (*Vf*) situated between wave *v* and the next jugular pulsation, is more gradual in its descent, is deeper, and occupies a longer time in the cycle.

The first positive wave, *a*, is presystolic in time and is invariably interpreted as being due to the contraction of the auricle. The

mechanism of its causation, however, admits of several interpretations. It may be due to the slowing or arrest of the venous flow with a resulting damming of the blood and increase in the diameter of the veins, or to the suddenness with which the blood stream is stopped, this giving rise to a wave travelling in a reverse direction. It may also be due to the propagation of a wave of regurgitation from the auricle.

Certain investigators, as Fredericq and Nuel,[14] do not believe that any regurgitation occurs in the great veins during auricular systole, under physiological conditions. On the other hand, Chauveau and Faivre[15] state, that in the horse there is normally a

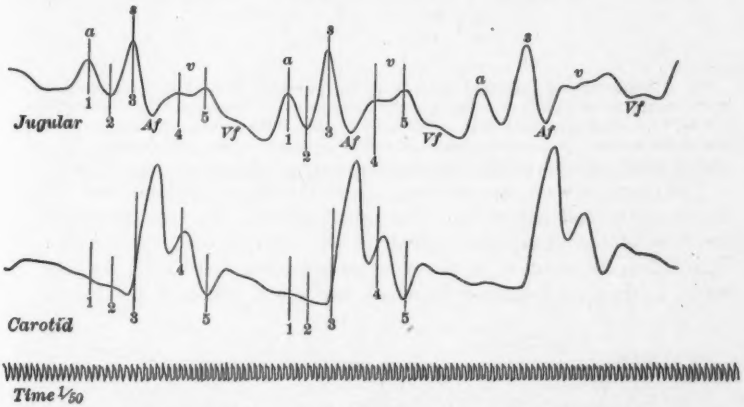

FIG. 1.—Simultaneous tracings of the jugular and the carotid pulses. From a case of mitral insufficiency and stenosis with perfect compensation. (Was admitted in the hospital for hydrops of the gall-bladder.) *a*, auricular wave; *s*, systolic wave; *v*, ventricular wave; *Af*, auricular filling; *Vf*, ventricular filling. The ordinates having the same numbers mark synchronous points on the curves. The letters and numbers have the same significance in all the tracings.

slight regurgitation of blood into the great veins during the contraction of the auricle. Keith[16] advances the opinion that the mouth of the superior vena cava is normally closed during the systole of the auricle by the contraction of a muscle band, the tinea terminalis, which performs the function of the venous valves found in the hearts of reptiles and batrachians. Should the auricle become engorged, however, the relaxation of this muscle band would allow of regurgitation into the veins, and Mackenzie thinks that it is easily rendered incompetent by changes affecting the tonicity of the auricle.

[14] Elements de physiologie humaine, Gand, 1893.

[15] Nouvelles recherches experimentales sur les mouvements et les bruits normaux du coeur, envisagés au point de vue de la physiologie médicale. Gaz. med. de Paris, 1856, iii série, t. xi, p. 406.

[16] The Evolution and Action of Certain Muscular Structures of the Heart. Lancet, February 27, 1904 and March 5, 1904.

It is probable, however, that in the normal state the main factor in the formation of this wave is to be found in the slowing of the venous current, and the resulting accumulation of the blood in the veins, and, possibly, also in the production of a centrifugal wave originating through the sudden arrest of the inflowing blood.

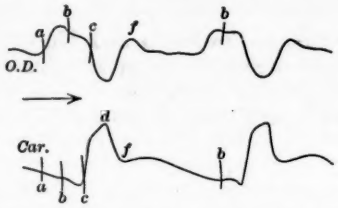

FIG. 2.—Simultaneous tracings of the intra-auricular pressure (*O.D.*) and of the pressure in the carotid artery (*Car.*) of a dog (morphine anesthesia). (Fredericq.) *a b*, auricular systole; *b c*, beginning of ventricular systole and projection of the auriculo-ventricular valves toward the auricle; *c d f*, outflow time; *f*, closure of semilunar valves (dicrotic notch).

The negative wave seen between *a* and *s* is easy of explanation. It is due to the collapse of the veins occurring with the resumption of the flow of the blood consequent on the relaxation of the auricle. This fall in the curve is, however, quickly interrupted by the positive wave, *s*, the interpretation of which has given rise to a great deal

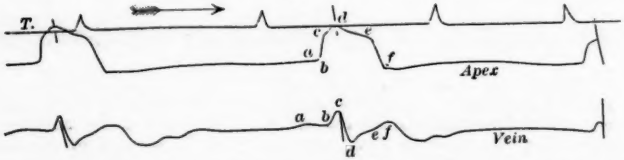

FIG. 3.—Simultaneous tracings of the apex beat and of the jugular pulse obtained from a large dog (morphine anesthesia). (Fredericq.) *a b*, auricular systole; *b c*, beginning of ventricular systole and projection of the auriculo-ventricular valves toward the auricle; *c d e*, (on apex tracing) systolic plateau; *e*, closure of semilunar valves; *e f*, relaxation of ventricles; *T*, time in seconds.

of controversy. It will be noticed that it is systolic in time, more correctly protosystolic, for it is normally synchronous with the beginning of ventricular systole. It reaches its height in the interval comprised between the beginning of the contraction of the ventricle and the opening of the semilunar valves, in other words, in that part of the cardiac cycle designated by the French as "systole préparatoire," and by the Germans as "Verschlusszeit" (Figs. 2, 3, and 4).

This wave was formerly considered abnormal and as being due to tricuspid regurgitation. This has been shown to be incorrect, as the jugular veins of normal animals exhibit it. Several explana-

tions have been offered concerning its mode of production. Friedreich attributed it to the impact of the aorta against the superior vena cava. As already stated, François Franck believed it to origi-

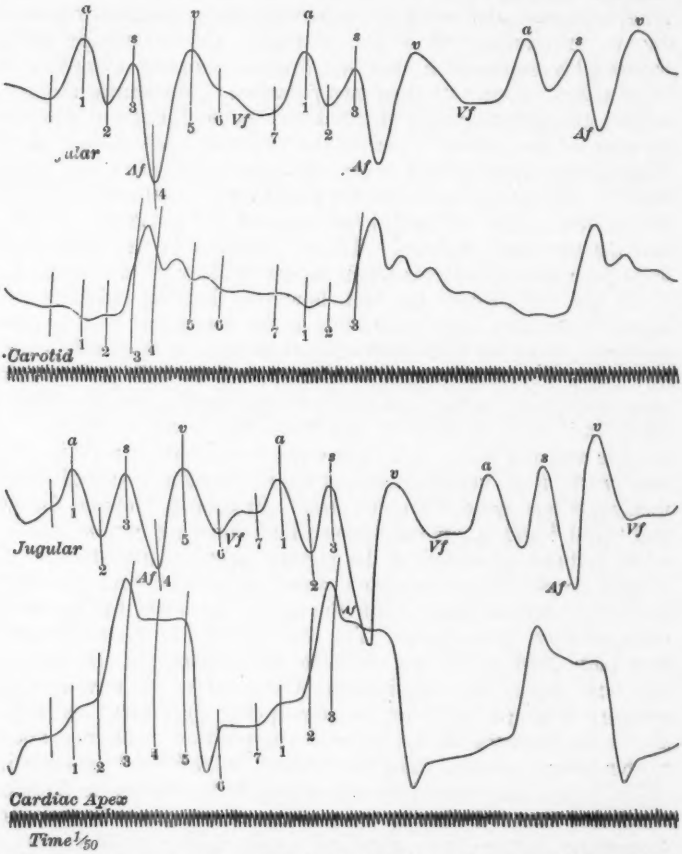

FIG. 4.—Simultaneous tracings of the jugular and the carotid pulses and of the jugular pulse and apex beat. Note that the upstroke of wave *s* coincides with the upstroke of the ventricular contraction (ordinate 2). Accordingly wave *s* precedes the carotid pulse by about 5/100 second. Wave *v* in this case is single. (Case of aortic regurgitation and relative mitral insufficiency with failing compensation.)

nate in the sudden closure of the tricuspid valve, while Fredericq thought it was due to the projection of these valves toward the cavity of the auricle. Gerhardt[17] does not think that this latter explana-

[17] Klin. Untersuchungen über Venenpulsationen. Arch. f. exp. Path. u. Pharm., xxxiv, 402. Einige Beobachtungen am Venenpulse, Arch. f exp. Path. u. Pharm., 1902, xlvii, 250.

tion is warranted. He considers that the auriculoventricular opening is so tightly closed by the sphincter action of the ring of muscle around it, that as a result the valve leaflets are kept almost completely in apposition and that therefore they could not be pushed toward the auricular cavity by the sudden rise in ventricular pressure due to the contraction of the ventricle. He accordingly prefers Friedreich's explanation that the arteries coursing alongside the veins animate them with their own pulsation. Mackenzie adopted a similar interpretation, and he attributes the production of this wave as seen in the jugular pulse to the communicated impact of the neighboring carotid artery; hence the name he gave to it of "carotid wave." Mackenzie has advanced a number of arguments in support of his view. It is not within the scope of this paper to take them and discuss them seriatim. Those interested in the subject will finds the necessary information in papers by Morrow[18] and by Bard.[19]

No one will dispute the fact, however, that the pulsation of a contiguous artery may contribute to the formation of this wave. However, I do not believe that it arises entirely from this source, but rather that it is independent of it, and that all the pulsation of a neighboring artery can do is to add itself to it, or vitiate it. Bard states that he obtained this wave from a vein in front of the clavicle and that it occurs in those cases in which the carotid is pulseless, provided the ventricles do not fail to contract. Animal experimentation has made this point clear. Fredericq, Morrow, Cushny and Grosh[20] and others have shown that this wave can be obtained when methods of recording the jugular pulse are used that do not involve pressure over the carotid artery, as well as when the vein is carefully dissected away from the artery, or when the carotid is clamped close to the aorta. The objection can be raised, however, that these methods do not eliminate the influence of the aorta on the vena cava. An examination of the curves of intra-auricular pressure obtained by Marey, Fredericq (Fig. 2), Porter[21] and others shows the presence of this wave in the position mentioned above. Porter ascertained that when the ventricle is inhibited by stimulation of the vagus, this wave does not appear in the curve; he therefore concluded that it is due to the pushing of the auriculoventricular diaphragm toward the auricular cavity. The venous tracings illustrating this article show a striking resemblance to the curves of intra-auricular pressure given by Porter in his valuable paper.

That wave *s* is really independent of any arterial pulsation is shown by the fact that, in the majority of cases, it precedes the systolic

[18] The Venous Pulse. Brit. Med. Jour., 1907, 777. The Various Forms of the Negative or Physiological Venous Pulse, ibid., 1906, 1807.

[19] De l'enregistrement graphique du pouls veineux des jugulaires chez l'homme. Jour. phys. et path. gener., 1906, t. VIII. Des divers détails du pouls veineux des jugulaires chez l'homme, ibid.

[20] The Venous Pulse. Jour. Amer. Med. Assoc., No. 15, xlix, 1254.

[21] Researches on the Filling of the Heart. Jour. Physiol., Cambridge, 1892, xiii, 513 to 553.

line of ascent of the carotid pulse. So far as I am aware, Bard was the first to direct our attention to this point. An examination of the tracings shown here will reveal the truth of this assertion. In order to demonstrate this the tracings must be taken on a kymograph revolving at a sufficiently rapid rate to bring into evidence little

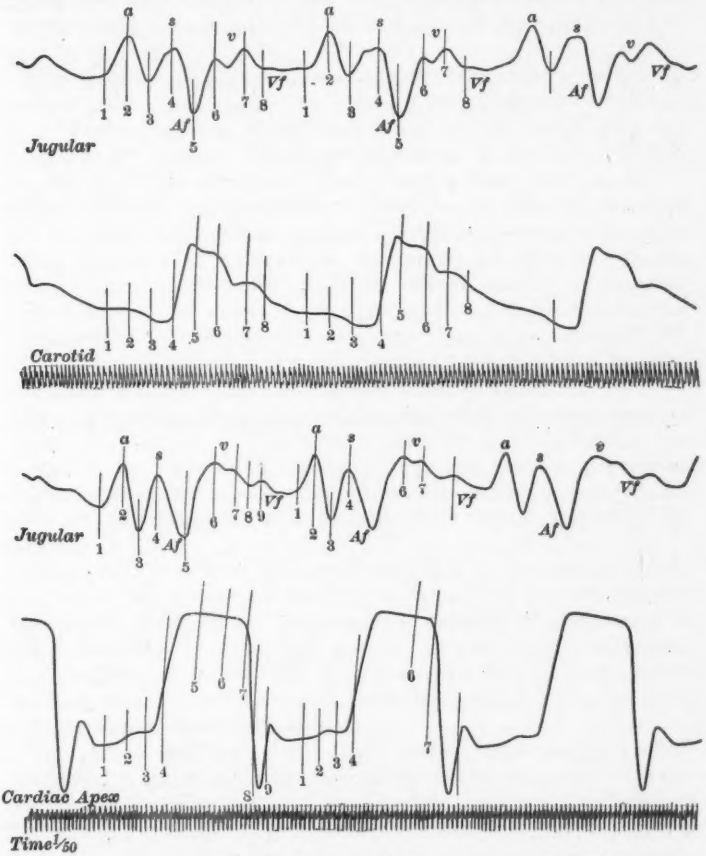

FIG. 5.—Simultaneous tracings of the jugular and the carotid pulses and of the jugular pulse and apex beat. From the same patient as Fig. 4 during a period of improvement.

differences of synchronism in the curves, and synchronous points should be marked with the levers in the manner already described, or by any other accurate method. The time elapsing between the beginning of wave *s* and the beginning of the carotid pulse varies in accordance with the degree of completion of the line of descent of the auricular wave, the rapidity with which the ventricle responds

to the stimulus coming from the auricle as well as the rapidity and ease with which the ventricle overcomes the pulmonic pressure. This is well exemplified in Fig. 6 taken from a case of mitral stenosis

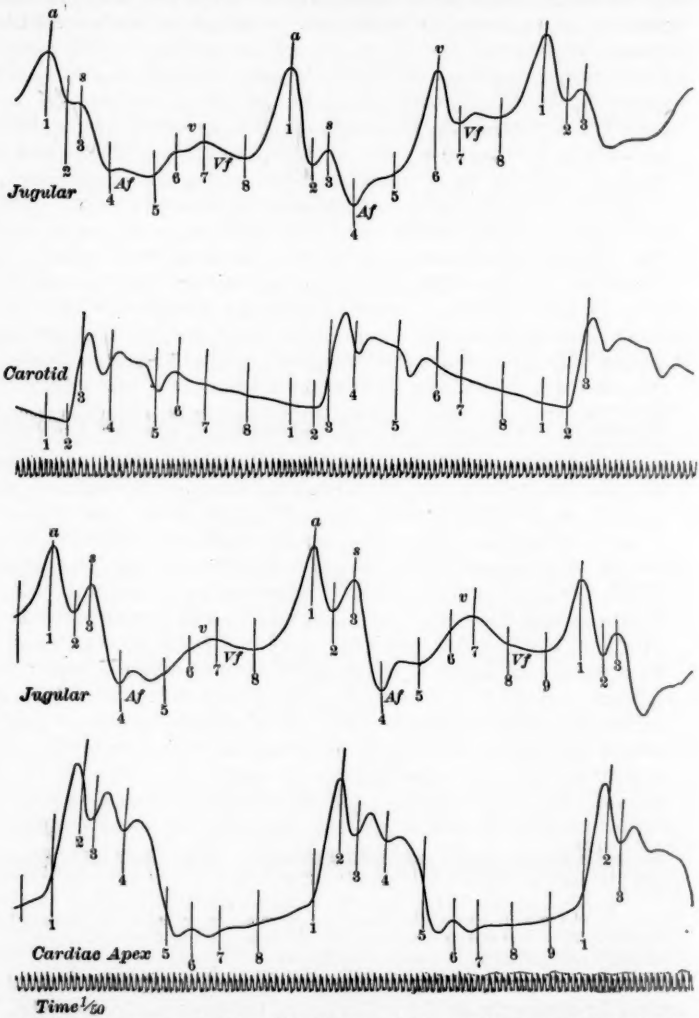

FIG. 6.—Simultaneous tracings of the jugular and the carotid pulses and of the jugular pulse and apex beat. Wave *v* occurs later in the cycle than in the other tracings. With the exception of the middle group, wave *s* begins with the carotid pulse. An examination of the lower tracings show tnat the ventricle responds quickly to the auricular impulse; wave *s* therefore occurs on the descending limb of wave *a*. (Case of mitral stenosis and regurgitation with beginning failure of compensation.)

in a fair state of compensation. According to Bard the difference in time between the appearance of this wave and the carotid pulsation, varies from $\frac{1}{100}$ to $\frac{2}{100}$ of a second. Until the present time, most of the tracings I have been able to obtain show somewhat higher figures, $\frac{4}{100}$ to $\frac{6}{100}$ of a second; in a few instances, however, Bard's figures were confirmed. In the middle group of Fig. 6, the time interval between ordinate 2 and the beginning of the carotid pulse is $\frac{2}{100}$ of a second.

Following the protosystolic rise *s*, a sudden fall occurs in the tracing producing the negative wave *Af*. This wave is generally attributed to the rapid emptying of the veins which takes place during the diastole of the auricle. The negative pressure in the auricle is due, not only to the dilatation of its valls, but in great part also to the action of the contracting ventricle. Chauveau and Marey[22] observed that the auriculoventricular septum is displaced toward the apex during the systole of the ventricle, this having for effect an enlargement of the auricular cavity. Porter offered another explanation of the production of a negative pressure in the auricle based upon the investigations of Purkinje, Nega, and Roy and Adami. He believes that it is due to the contraction of the papillary muscles pulling the auriculoventricular valves toward the ventricle.

Some investigators have thought tbat this negative wave is caused by changes in intrathoracic pressure coincident with the change in the volume of the heart occurring during ventricular systole. Gottwalt[23] showed this conception to be incorrect, inasmuch as this negative wave persists even though the chest be opened.

This wave, then, is indicative of the filling of the auricle, and is the product of several factors: the expansion of the auricle, the downward movement of the auriculoventricular septum, and the pull exerted by the papillary muscles on the auriculoventricular valve leaflets. It begins with the opening of the semilunar valves and lasts until toward the end of ventricular systole, when the third positive wave makes its appearance.

The normal position of the third positive wave usually called ventricular wave, *v*, is toward the end of ventricular systole. However, different observers do not agree to this, and some, like Gerhart, believe it to occur during ventricular diastole. The fact is that the relation of this wave to the cardiac cycle is not perfectly constant, and that pathological conditions within the heart seem to influence both its position and its form. It is not the purpose of this paper to discuss the pathological modifications of the venous pulse; I shall, therefore, consider it only as it occurs normally in the jugular veins of animals, and in those human beings who exhibit venous

[22] Appareils et expériences cardiographiques, Mém. acad. med., Paris, 1863, t. xxvi, 313.
[23] Der normale Venenpuls. Arch. f. die ges. Physiol., 1881, xxv, 1.

pulsations either without apparent pathological cause or as a result of some slight venous embarrassment.

Various explanations have been offered concerning the interpretation of this wave. Some, like Rigel, think that it is due to the communicated shock of the arterial dicrotic expansion; others, among whom is François Franck, see in it the effect of changes in intrathoracic pressure owing to the diastolic enlargement of the ventricle. But it has been shown that opening the thorax in animals does not affect the production of this wave. Mackenzie and others believe that it is due to the filling of the auricle and the consequent accumulation of the blood in the veins. Mackenzie, however, associates it in some way or other with tricuspid regurgitation.

While it is in all probability true that tricuspid regurgitation affects the *v* wave, it is none the less true also that it occurs in cases in which there is no regurgitation. It is found as a constant wave in the jugular pulse of animals, as well as in the curve of intra-auricular pressure. Moreover, the mechanism of its production is to be sought in the movements of the ventricle. Fredericq, Gerhart, Wenckebach, and others have ascribed it to the swinging back of the auriculoventricular septum. Morrow does not believe that the action of the ventricle is necessary for the formation of this wave, but Cushny and Grosh have shown that the suspension of the ventricular contractions is attended with the disappearance of this wave from the tracing.

It was stated above that two of the factors contributing to the formation of the negative wave *Af* are, on the one hand, the displacement of the auriculoventricular septum toward the apex, and, on the other hand, the pull of the papillary muscles on the tricuspid leaflets.

The relaxation of these papillary muscles and the return of the auriculoventricular septum to its former position decrease the cavity of the auricle, and, as the latter is filled, this encroachment upon its capacity has for effect an arrest of the flow and a damming of the blood in the veins. These two movements, however, are not synchronous, and, according to the researches of Roy and Adami,[24] the papillary muscles relax shortly before the beginning of ventricular diastole, hence before the return of the auriculoventricular septum to its position of rest. This relaxation occurs while the intra-ventricular pressure is still much higher than the intra-auricular pressure. We should, therefore, expect these two separate movements to be reflected in the wave under consideration. That this may be as here explained is seen by the constancy with which a notch is present on the summit of wave *v*, thus showing it to be made up of two lesser waves.

[24] Heart Beat and Pulse Wave. Practitioner, London, 1890, xliv, 81, 161, 241, 347, 412; xlv, 20.

The variations in the form and in the position of this wave in the cardiac cycle are to be sought in pathological factors which may mask or annul the effect of the movements just described.

The third negative wave in the jugular pulse, *Vf*, occurs at the beginning of ventricular diastole, and is due to the opening of the tricuspid valve; the auricular blood entering the relaxing ventricle, the flow of the blood in the veins is accelerated, and the latter naturally decrease in diameter.

In almost all tracings taken from normal animals, either from the jugular vein or from within the auricle, this wave is more shallow than the negative wave *Af* (auricular filling). Although the tracing of Fig. 5 was taken from a pathological case of aortic and mitral regurgitation, what may be taken as the normal ratio of the depth of these two waves is well shown there.

It seems at first strange that this negative wave should be so little marked, but if it be remembered that the base of the ventricle may still be continuing its upward movement, though perhaps more slowly, it will be easily understood how this would counteract the effect of the aspirating action of the ventricle by gradually decreasing the capacity of the auricle.

A slight positive wave is very constantly present at or near the trough of this negative wave. It is in all probability a wave of stasis due to the entrance of blood into the veins from the periphery.

A moment's consideration will make it apparent that the study of the venous pulse by the graphic method is destined to give valuable information concerning the pathological function of the heart, for it can reasonably be inferred from what has been said, that it mirrors, more faithfully than the arterial pulse, the events occurring within the heart. Already it has proved invaluable in the study of heart-block, and in the study of the various forms of arrhythmia.

Conclusions. The physiological or so-called negative systolic venous pulse consists of three positive and three negative waves bearing a more or less definite relation to the events of the cardiac cycle and having their origin in the various movements of the chambers and structures of the right heart. The first positive wave (*a*) is presystolic in time and is due to the contraction of the auricle causing a slowing of the venous current and producing a centrifugal wave through a sudden arrest of the inflowing blood. The second positive wave (*s*) is protosystolic in time and originates in the sudden projection of the tricuspid valve into the cavity of the auricle during the quick, incipient rise in intraventricular pressure occurring in the protosystolic period. The third positive wave (*v*) occurs toward the end of ventricular systole. It consists of two lesser waves separated by a shallow notch. The factors entering into its formation are the relaxation of the papillary muscles at a time when the intraventricular is still higher than the intra-auricular pressure, this resulting in an upward movement of the

tricuspid leaflets, and to the return of the auriculoventricular septum to its position of rest.

The first negative wave (between positive wave *a* and *s*) is due to the relaxing auricle. The second negative wave (*Af*) occurs during the diastole of the auricle. It is due to the dilatation of its walls, to the displacement of the auriculoventricular septum toward the apex occurring at the time of ventricular systole, and to the pull of the papillary muscles on the tricuspid valve leaflets. The third negative wave (*Vf*) appears during ventricular diastole and in the common pause of the heart chambers. Its cause is found in the passage of the blood from the auricle into the ventricle. It is somewhat modified, possibly by the continued ascent of the auriculoventricular septum and by a wave of stasis due to the accumulation of blood coming from the periphery.

I wish here to thank Professors A. P. Brubaker and W. M. L. Coplin for their encouragement and advice, and Professors J. C. Wilson and H. A. Hare from whose wards the necessary material was obtained.

FATIGUE IN SCHOOL CHILDREN AS TESTED BY THE ERGOGRAPH.

By Rowland G. Freeman, M.D.,

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The considerable number of children seen in dispensary service, particularly late in the winter and in the spring, suffering from nervous disorders, and the fact that these children are usually conscientious children who are making a desperate effort for a good showing at school, naturally leads one to suspect that school work is doing, at least some of the children, considerable harm. This feeling, I believe, is also shared by many school teachers.

Being interested in the physical welfare of the children in a large private school in New York, my attention was attracted to the work with the ergograph done under the direction of Dr. W. S. Christopher in the Chicago public schools during the years 1898, 1899, and 1900. Dr. Christopher was placed in charge of a department of child study, and undertook to apply various tests to the children so that each child might be so placed in school as best to acquire knowledge without physical harm. He tested the sight, hearing, lung capacity, etc. Among the various tests he applied to the children was a test of muscular activity, determined by the ergograph. The ergograph, which aims to use only one muscle and to exercise it until fatigue is produced, shows by comparative tests muscular fatigue. Dr. Christopher tested the children during various periods of the school day,

and found in a considerable number of experiments that there is a diminution in the physical activity as shown by the ergograph, commencing within an hour of the beginning of the school day and proceeding until the noon recess, after which about the same activity was shown as at nine in the morning, but it fell off again during the afternoon session. The report of 1899-1900 notes one exception to this rule, and that was in four boys, who, on questioning, stated "that their teacher had been called from school and that they had had no regular work, but had been sent to another room but employed themselves, as they said, in having a good time."

The amount of deterioration in muscular activity during the school day, as shown in these children, was on the average during the first experiments from 20 to 25 per cent. A later average of 1127 records of one school showed a morning loss of 16 per cent., and an afternoon loss of only 4 per cent. This slighter evidence of fatigue, in the afternoon might be attributed to the fact that the most difficult school work is now arranged in the morning curriculum.

These very valuable observations by Dr. Christopher were published, but, so far as I know, no practical application was made of them; that is, no attempt was made to work out a school day which might reduce or eliminate fatigue, for it has been well demonstrated that fatigue, as shown by the ergograph, is very marked fatigue, for after slight fatigue a better tracing may be obtained than with no fatigue.

It seemed to me probable that by the use of more frequent recesses such fatigue might be eliminated and a school day elaborated, which would be free from constant marked fatigue and would keep the children in a condition more favorable to the acquisition of knowledge and without physical harm.

My first efforts to measure fatigue in school children were undertaken at the Charlton School three years ago. Two tests for fatigue were then used: that suggested by C. Ward Crampton, of New York, which consists in obtaining the difference between the blood pressure of a child standing and in a horizontal position, and the rapidity of the heart action in a child standing and in a horizontal position. This test was used in combination with a test by an ergograph devised by Dr. Thomas A. Storey and kindly lent to me by Professor Lombard, of Ann Arbor, in which the abductor indicis was used; each movement of the index finger toward the thumb raising a weight and making a tracing on a kymograph. Throughout this work I have been much indebted to Professor F. S. Lee, of the department of physiology of the College of Physicians and Surgeons, of Columbia University, for his wise advice and for the laboratory facilities and laboratory apparatus put at my disposal.

With these two tests I used children who were first required to concentrate in their studies; that is, children of about seven years. Absolutely no appreciable evidence of fatigue was obtained from the

Crampton test of blood pressure and pulse rapidity, and no general fatigue such as that described by Dr. Christopher was obtained by the use of this ergograph. Although slight fatigue was usually shown by some children, no persistent marked fatigue was ever found in any class of children.

The following year I continued the same experiments with the same apparatus in older children at the Charlton School with similar results. One ambitious and conscientious girl of high standing, with an acute mind, who was anemic and poorly nourished, showed constant fatigue after her morning work. Some others showed occasional fatigue, others none.

Having worked for two years with very little result in this school I arranged during the past winter to conduct work in the public schools, and through the courtesy of Health Commissioner Darlington and Superintendent Maxwell of the Board of Education, and Superintendent Boyle, of Public School 69, I was enabled to obtain the facilities that I needed. I used for this purpose at first girls eleven years old, taking first a group of five whom their teacher thought were fatigued at the end of the school day. These children, who were apparently showing some fatigue, showed no marked fatigue such as Dr. Christopher observed in Chicago. Other groups of five children of the same age that were afterward taken gave similar results. I therefore concluded that further work with this ergograph was useless, either in order to confirm or obtain conclusions on the work done by Dr. Christopher.

I then procured a Mosso ergograph (Fig. 1), similar to the one used in Chicago, which was kindly lent to me by Professor Howell of Johns Hopkins University, and to this was attached an adder. This Mosso ergograph uses the flexor of the middle finger. It was arranged so that each flexion of the middle finger raises a weight, makes a tracing on the kymograph as well as registering the amount of work done on the adder. In the use of this apparatus the method followed in Chicago was adopted, each child pulling 7 per cent. of his weight thirty times a minute for one and one-half minutes, thus giving each child about forty-five pulls.

With this apparatus I have tested a considerable number of children in a New York public school and have obtained results exactly similar to those obtained with the other form of ergograph which I previously used. While some children show fatigue in their tracings after an interval of school work, other children will make better tracings than at the beginning.

Twenty children tested 9.30 A.M. showed an average of 264 kg. cm. of work; at 11.30, 286; at 1.30, 272, and at 3.30, 250. This shows a slight increase in muscular activity at 11.30 over 9.30 and again a slight diminution at 2.30 as against 1.30 (Fig. 2).

An average of 36 observations at 9.30 and 11.30 on both boys and girls from ten to fourteen years of age, gave an average result of 278

kg. cm. at 9.30 and 282 kg. cm. at 11.30, a slight increase in the amount done at 11.30 over 9.30. As some of these children were

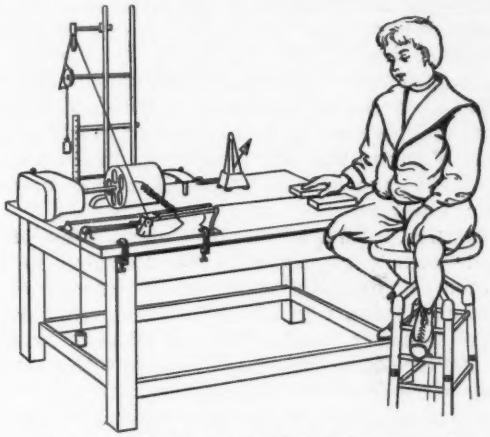

FIG. 1.—A child being tested with the Mosso ergograph.

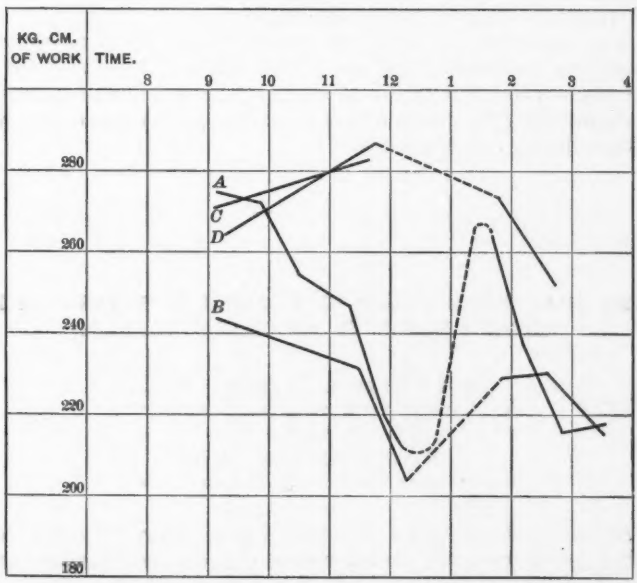

FIG. 2.—Influence of school work on physical activity. *A*, 8 Chicago public school children; *B*, 1127 Chicago public school children; *C*, 36 New York public school children; *D*, 20 New York public school children.

using the instrument for the first time on this day an estimate of the work done by children who had repeatedly used the ergograph might help to eliminate this possible error. Eleven children familiar with the instrument did an average of 204 kg. cm. of work at 9.30 and 256 at 11.30, so that there seems no way that we can use these figures to obtain results similar to those obtained by Dr. Christopher. This may be accounted for by a difference in the school curriculum. It is possible that the duties required of the pupils in Chicago are more difficult and that the sessions possess less opportunities for recesses. This would, of course, alter the results. As I have been unable to obtain the curriculum used in Chicago I cannot compare it with that used in New York.

As a conclusion, I might say that the Crampton test for fatigue has given negative results as applied to school children in New York; that the Storey ergograph as used for the detection of fatigue in school children has given negative results and is unsuitable on account of the use of accessory muscles when the abductor indicis becomes fatigued; that the Mosso ergograph combined with an adder as used in the Chicago public schools is the more reliable instrument for this purpose, but in my hands fails to give evidence of marked fatigue of the pupils during the school day in a private and also in a public school of New York City; and that in occasional children either form of ergograph will give evidence of fatigue.

The ergograph, so far as my work indicates, is of no value in modifying the school day in the public schools of New York for the average student, but might be shown to be of value in lightening and controlling the work for those pupils who give evidence of marked fatigue during the school day.

THE DIAGNOSTIC VALUE OF CUTANEOUS HYPERALGESIA (HEAD'S ZONES) IN ABDOMINAL DISEASE.

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Although fifteen years have passed since Henry Head first published his discovery of the association of increased sensitiveness of the skin with visceral disease, the literature of the subject has remained very small. Lange is said to have written about skin sensitiveness in visceral disease as early as 1871. Ross referred to

the subject in 1888, but Head was the first to make a careful study of the phenomena. Notwithstanding the importance of Head's publication, it seems to have attracted little attention outside of England. The papers of Mackenzie, Thorburn, Thane, and others, in England, and of Petren and Faber, on the Continent, are the only ones of importance that have appeared. In most of the text-books the subject has been dismissed with a few lines.

During the last two years we have made a large number of examinations in the wards of Mt. Sinai Hospital, to determine the presence or absence of areas of hyperalgesia in abdominal affections. The majority of the patients were admitted to the surgical service of Dr. Lilienthal, and were sooner or later submitted to operation, so that the results of our observations were verified by the operative findings. In the following paper are given the results of our studies, arranged under the following headings:

I. Description of Head's zones.
II. Methods to be used in testing for cutaneous sensitiveness.
III. The appearance and disappearance of zones of hyperalgesia in abdominal disease.
IV. The general significance of localized areas of cutaneous hyperalgesia in visceral disease.
V. General consideration of the subject of hyperalgesic zones in abdominal disease.
VI. Head zones in affections of the various viscera.
VII. Conclusions.

I. DESCRIPTION OF HEAD'S ZONES.

In 1893 and later, Henry Head described certain definite and constant areas of cutaneous tenderness associated with diseases of the different viscera. He found that in many visceral affections, if the sensitiveness of the skin was tested by running a pin point over the cutaneous surface, there could be shown to exist areas over which there was a more or less marked hypersensitiveness to pain. As a result of painstaking investigations extending over many years, he concluded that these areas were constant and distinct; they could be mapped out on the surface of the skin, and, when present, were an almost infallible sign of an affection of the organ to which they corresponded. The skin tenderness was very superficial—quite different from tenderness on deep pressure—and extended over definite areas which never overlapped one another. Each area or "zone of hyperalgesia," as he called it, had a "maximum" region, which often corresponded to the location of the pain complained of by the patient, and coincided with the areas marked out by attacks of herpes zoster. Head found, also, that these areas were hypersensitive to heat and cold, but not to touch. He concluded that there is

an intimate association between the central connections for the nerves of the viscera and the nerves which supply the sensations of pain, heat, and cold, and those which exert trophic influences on the skin.

In his various publications, Head gave diagrams of the form and extent of these hyperalgesic zones. He showed that the areas corresponded to segments of the spinal cord, not to the distribution of peripheral nerves or spinal nerve roots or brain areas. Based on this segmental distribution, the zones were named according to the segments of the spinal cord: cervical, 1 to 7; dorsal, 1 to 12; lumbar, 1 to 5; sacral, 1 to 4. Head described the shapes of the zones, and stated that in general the zones were broader at the median line in front, became narrower at the side of the body, and again broadened out near the spinal column. The zones of each side never extended beyond the median line in front or behind.[1] Head stated, also, that there were individual differences in the form of the areas, but not in their general position, due to variations in the shape of the patient's body or in nerve supply.[2] For the abdominal viscera, Head gave the following zones:

Stomach, sixth, seventh, eighth, and ninth dorsal.
Cardiac end, sixth and seventh dorsal, right.
Pyloric end, eighth and ninth dorsal, left.
Liver, eighth, ninth, and tenth dorsal, right.
Gall-bladder, eighth and ninth dorsal, right.
Intestines, ninth, tenth, eleventh, and twelfth dorsal.
Colon, ninth, tenth, and eleventh dorsal.
Cecum and appendix vermiformis, tenth and eleventh dorsal, right.
Kidney, tenth dorsal, sometimes eleventh dorsal.
Ureter, eleventh and twelfth dorsal, first lumbar.
Bladder, (first?), second, third, and fourth sacral.
Uterus, tenth, eleventh, and twelfth dorsal, first lumbar.
Appendages, eleventh and twelfth dorsal, first lumbar.

To explain these areas of referred cutaneous hyperalgesia, Head proposed an hypothesis, which we here give in his own words:

"Why is the skin tender in consequence of visceral disease?

"If impulses pass up the sensory nerves from an organ which is diseased to the cord, they will set up a disturbance in the segment of the cord to which they are conducted. Now, any second sensory impulse from another part conducted to the same segment of the cord will be profoundly altered. Under normal circumstances, it would have set up its own proper disturbance in the gray matter,

[1] In a few instances we have observed that the areas extended slightly across the median line in front. This can be explained on the basis of nerve filaments from one side supplying the skin a little beyond the median line.

[2] The outline of the zones, as determined by us, sometimes varied somewhat from Head's diagrams (see below).

and this disturbance would have been conducted to the brain. But now it no longer falls into a normal and quiescent cord, but into one whose activity is already disturbed. The resultant stimulus conducted upward is therefore a very different one from that which would have passed on under normal circumstances. In many cases the second stimulus will be exaggerated like rays passing to the eye through a convex glass. Thus, if any segment of the cord is disturbed by painful stimuli from an internal organ, a stimulus applied to the skin over the areas supplied by the nerve roots belonging to this segment will be exaggerated, and a stimulus which normally was perhaps only uncomfortable would now appear to be very painful.

"But in order that this condition may result, the central nervous connection between the sensory nerves from the viscera must be closely connected with that part of the cord into which the sensory stimuli from the skin are conducted. We never find cutaneous hyperesthesia or increased sensitiveness to touch as the result of visceral pain, but only increased sensitiveness to pain or hyperalgesia."

II. METHODS OF EXAMINATION.

No satisfactory and practical form of algesimeter for testing cutaneous hyperalgesia has thus far been devised.[3] Head tested the skin sensitiveness to pain by pinching up folds of skin, or, later, by stroking the skin with the point of a sharp pin. We have made use of the pin method, and have found it satisfactory for practical purposes. A sharp pin is held between the thumb and index finger of the right hand, the nail of the index finger resting on the patient's skin. The pin is then made to traverse slowly the surface of the skin, care being taken that the nail of the index finger presses equally along the area examined. The patient is instructed to say "now" as soon as the pin stroke becomes painful.

In examining the skin of the abdomen for hyperalgesic areas, the pin traverses the abdomen from side to side and from above downward; the points at which the patient complains of pain are marked. In this manner it is possible to map out areas on the skin, and when such an area has been found, the pin is made to approach it from all sides, so that its form and position can be determined. Care must be taken that the pressure of the pin point remains constantly the same, especially as the pin passes over the groin and slips off the costal border or over the crest of the ilium.

After the zone has been thus mapped out on the skin the procedure is repeated a second time, and now it is a good plan for the operator to control both patient and himself by keeping both the patient's

[3] The instrument described by Thudicum is not practical.

and his own eyes away from the pin. There is considerable variation in the sensitiveness of different persons; some will complain of pain with a pressure which others will hardly feel. It is therefore of advantage first to gain an idea of the general sensitiveness to pain of the patient.[4]

The hyperalgesia is sometimes so marked that the patient will shrink or cry out as soon as the border of the zone is reached. At other times one depends on the statements of the patient.[5] In very young children, the examination is useless, but older children will give correct answers.

If the examination is carried out in the manner above described, it will be possible in a large number of patients with visceral affections to map out areas of hyperalgesia extending from the median line in front to the spines behind. We have succeeded in substantiating most of the statements made by Head in regard to the zones of referred cutaneous hyperalgesia in abdominal disease. The "maximum" areas can often be mapped out lying within the boundaries of the zones; sometimes only the "maxima" are present. We have sometimes found several "maxima" in one zone.[6]

A certain amount of experience is necessary before satisfactory results can be obtained, and this experience must be gained by frequent careful tests for cutaneous hyperalgesia. We have found, with increasing experience, an increasing number of positive cases.[7]

III. THE APPEARANCE AND DISAPPEARANCE OF ZONES OF HYPERALGESIA IN ABDOMINAL DISEASE.

The zones appear early in the course of visceral affections, and usually persist throughout the course of the disease. They disappear at once with the relief of the lesion. They may appear very early. Thus, in the very beginning of acute appendicitis, when the pain is still in the epigastric region, and there is no tenderness as yet in the right iliac region, there may be a well-marked appendix zone. The zones may appear after palpation, when they were not present before. Thus, we have seen the characteristic

[4] For this purpose we have sometimes found a test proposed by Dr. Libman of value. If one makes pressure with the thumb over the styloid process in the neck, one may gain a fair idea of the degree to which an individual is sensitive to pain. Some patients will complain of the slightest pressure, in others a considerable degree of force is required. (Personal communication through kindness of Dr. E. Libman, adjunct physician to Mt. Sinai Hospital.)

[5] It is often a good plan to control the patient's statements by testing the skin near the spine on the side opposite to that on which the zone has been found. This is, of course, done without the knowledge of the patient.

[6] Although, in front, the hyperalgesia may extend only over a small "maximum" area, the examination of the skin of the back should never be omitted. There may be a sensitive area posteriorly which will make the identification of the zone more certain.

[7] Thus, in the beginning of our investigations we were able to demonstrate zones of hyperalgesia in about 25 per cent. of cases of appendicitis; after some experience we have found "appendix zones" in almost 75 per cent. of the patients.

zone for the appendix appear after palpation of the right iliac region in acute appendicitis, and we have observed the zone for the uterine adnexa appear after a bimanual examination. Head states that, in one of his patients, after rough manipulation of a floating kidney, a "kidney zone" appeared.

In a few instances, we have been able to note the appearance of the zone while the patient was under observation. In these cases the zone usually appeared in its entirety. The presence of an ice bag, a hot-water bag, or a poultice may make it impossible for the examiner to map out the sensitive area, but if the ice bag or hot-water bag is removed, the hyperalgesic zone will appear after about fifteen minutes. Therefore, it is imperative to wait a short time after an ice bag, etc., has been removed before the examination is made.[8]

The disappearance of the zones is a question whose significance is often difficult of explanation. In general it may be stated that a prompt disappearance of the zone follows relief of the lesion of the affected viscus. We have, in a number of patients, been able to watch the disappearance of the zones. In some cases, the zone disappeared slowly as the condition of the diseased organ improved; the outlines of the hyperalgesia became irregular, until finally there was only a small area of hyperalgesia remaining. After several days it was impossible to state that the area found hypersensitive to pain corresponded to a segmental zone, because it had become so vague.

The zones may disappear after repeated examinations. Thus we have often observed that after the skin of a patient had been examined in succession by a number of the house staff, the zone became less and less distinct, and finally disappeared. After a short interval of rest the hyperalgesic area again appeared. We have always considered that this disappearance of cutaneous hyperalgesia after a number of examinations which followed each other in close succession was a sign that the nerves had become "tired out."[9]

The zones may disappear suddenly in the course of the visceral disease, with persistence or sudden increase in the general symptoms. We have seen this sudden disappearance of skin hyperalgesia in a number of instances, and shall speak of its significance later.

[8] In some cases the hyperalgesia is so intense that the zone can be mapped out in spite of the fact that the skin is more or less anesthetic from the cold. Care, however, must be taken that the cutaneous tenderness due to a bruise or superficial abscess is not confused with referred cutaneous hyperalgesia.

[9] It may be that the relief from pain obtained by the application of cold to the abdomen in acute abdominal disease is due to the anesthesia of the skin produced. On this theory we have, in some acute affections with Head zones, anesthetized the hyperalgesic area with menthol (50 per cent.). In some of the patients the pain was relieved.

IV. THE GENERAL SIGNIFICANCE OF LOCALIZED AREAS OF CUTANEOUS HYPERALGESIA IN VISCERAL DISEASE.

While the absence of a characteristic zone of cutaneous hyperalgesia in a suspected affection of an abdominal organ does not mean that there may not be a disease of that organ, the presence of the zone means that there is an undoubted lesion. From this one must not conclude that the viscus which gives the zone is the one which causes the symptoms, for we may get a zone from an organ which is secondarily affected. Thus we have seen, in several patients with marked abdominal distention in the course of typhoid fever, a zone of hyperalgesia of the tenth and eleventh dorsal segment on the right side corresponding to the cecum and vermiform appendix, an evidence of especial distention in those structures.[10]

The presence of a Head zone alone must not be the only factor in arriving at a diagnosis; it must be used in conjunction with other signs and symptoms. Used with circumspection, however, it will be found of value in very many patients.

The signs of not a few abdominal affections are so much alike that the presence of a Head zone may focus attention on one or the other organ, with the probability that the disease will be found in that organ. At any rate, the presence of a zone must focus the clinician's attention upon the corresponding organ, and lead to a more careful examination of the organ and its surroundings. When the symptoms and signs have left us in doubt which of several viscera was the seat of the lesion the presence of a zone corresponding to the one or other viscus has made the diagnosis possible. In not a few patients with marked abdominal distention and rigidity the presence of a characteristic zone has aided very much in making a differential diagnosis between disease of the gall-bladder and of the vermiform appendix, between disease of the gall-bladder and kidney, between disease of the appendix and female adnexa, etc. In early stages of abdominal disease, zones of hyperalgesia are also of value, and have aided us in making an early diagnosis.

There is no constant relation between the severity of the pain or the gravity of the lesion and the degree of sensitiveness of the skin; we have seen very marked zones with little subjective pain and slight lesions, and only slight hyperalgesia in patients with very severe pain and grave lesions.

A few facts must be mentioned concerning the significance in an abdominal affection of the sudden disappearance of a Head zone with the persistence of other symptoms and signs. We have given

[10] After distending the sigmoid flexure with air or fluid by means of a tube introduced into the rectum, one can often find a characteristic zone of hyperalgesia of the tenth and eleventh dorsal segments corresponding to the sigmoid.

especial attention to this point, but have not yet reached any positive conclusion. We do not agree with those who have claimed that the sudden disappearance of a zone means relief of tension in the corresponding viscus. Based on this, some writers have claimed, in acute appendicitis, for example, that with perforation of the appendix the zone should be absent or should suddenly disappear. We have observed a large number of cases of perforative appendicitis with persisting Head zone. (See Affections of the Appendix.)

We have gained the impression, however, that with persisting or increasing symptoms, the sudden disappearance of a zone is a sign of ill-omen and cause for concern. Thus, we have seen several patients with mild symptoms of appendicitis and with a Head zone suddenly develop very severe symptoms, making immediate operative interference imperative. Examination just before the operation showed that the appendix zone had disappeared.

The subject requires further study before any positive statements can be made.

The presence of areas of skin hyperalgesia corresponding to several viscera may mean a combined lesion of several adjoining viscera, although in these patients one has to think of a disease of the spinal cord itself. In this connection the following case is of interest:

A young girl with indefinite abdominal symptoms and with some tenderness in the right iliac region was sent into the hospital with the diagnosis of chronic appendicitis. Examination showed that there was some tenderness in the appendix region and some abdominal rigidity, with fever. There was an extensive area of skin hyperalgesia extending over the right side of the abdomen from Poupart's ligament to above the free costal border. This at once directed attention to the vertebral column and spinal cord. Careful examination revealed a slight scoliosis of the dorsolumbar vertebræ. An injection of tuberculin was followed by a marked general and local reaction; the *x*-rays showed beginning disease of several vertebræ. The patient was suffering from early Pott's disease.

V. GENERAL CONSIDERATIONS.

In what follows we shall speak of the zones by the names of the viscera to which they correspond rather than to the spinal segments to which they belong. Thus, we shall speak of gastric, gall-bladder, appendix, kidney zones, etc. Head has demonstrated conclusively the visceral associations of the various hyperalgesic areas; we believe it will add to the clearer understanding of the zones if they are directly named according to the viscera to which they correspond.

We desire to call attention to the fact that the zones of hyper-

algesia that we have found differ somewhat from the zones described by Head, both in outline and extent. Thus, the stomach zone, according to our experience, corresponds to the seventh, eighth, and ninth segments of Head (according to Head, sixth, seventh, eighth, and ninth); the gall-bladder zone to the eighth and ninth segments on the right side (same as Head's diagrams); the appendix zone, according to our experience, tenth and eleventh segments of Head on the right side. In our diagrams we have drawn the zones as we have found them in our cases. It will be

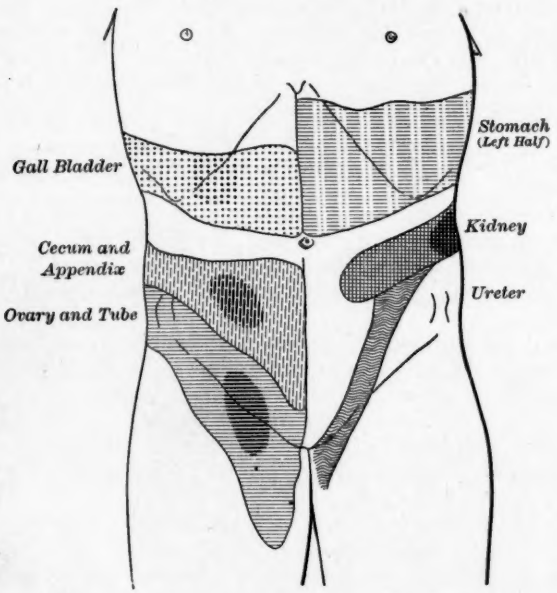

FIG. 1.—The general location and outline of the zones of cutaneous hyperalgesia for some of the abdominal viscera. Anterior view. The maxima are deeply shaded. Only the left half of the gastric zone is given. The ureteral zone consists of a series of maxima (diagrammatic).

found, in the description of the zones, that we do not absolutely limit the posterior portions. Thus, we say, in describing the gastric zone, that it extends from the sixth to the tenth vertebræ, approximately. The zones, except the gastric zone, stop sharply at the posterior median line, but their upper and lower margins are more variable.

The zone appears on that side of the body on which the affected organ has its nervous connections; the side on which the organ is normally situated. If an organ belongs on the left side, the hyper-

algesic zone will be found on that side, even if the organ, through disease or mobility, lies on the other side of the body.

We will call those areas "objective zones" when the patient suffers actual pain as the stroking pin enters them. All less painful zones will be called "subjective zones." By an "anterior zone" we mean an anterior maximal area; by a "posterior zone," a posterior maximal area.

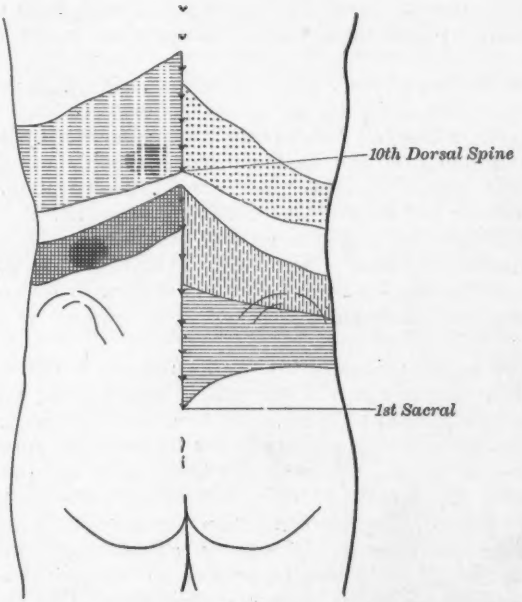

FIG. 2.—The general location and outline of the posterior parts of the zones (diagrammatic).

THE STOMACH. We have examined only a small number of patients with gastric affections, and have found the zones more variable in extent and configuration than in any of the other abdominal diseases. Head, in his original paper, stated that the gastric zones appeared most often on the right side. We have found that a complete gastric zone is uncommon. It extends as a broad belt all around the body. In the median line in front it extends from the xiphoid almost to the navel; it then passes upward and backward on both sides toward the spine, where it extends from the sixth to the tenth vertebra (approximately). Incomplete zones are more frequent, either an anterior portion extending to the right or to the left, or on both sides of the anterior median line. Zones were present in some of our cases of chronic gastric diseases with pain

(carcinoma, benign stenosis of the pylorus, chronic bleeding ulcer); more often in acute gastric affections (ulcer, acute dilatation, gastritis). We present a few illustrative cases:

Acute Bleeding Ulcer. There was a well-marked gastric zone in its left half, while the bleeding was going on; when bleeding and pain ceased, the zone disappeared simultaneously.

Benign stenosis of the pylorus in a patient who vomited once a day, at which time he had considerable pain and tenderness. Several times, after the vomiting, a complete gastric zone could be mapped out; at other times, only the anterior half on the zone was present.

Benign Stenosis of the Pylorus; Cholelithiasis. Five years' history of cholecystitis. During the last six months, occasional vomiting and frequent eructations not associated with attacks of cholecystitis. There were dull pain and moderate tenderness in the right hypochondrium; frequent nausea and eructations; vomiting. There was a complete gall-bladder zone extending to the left as far as the anterior axillary line, a narrow strip of hyperalgesia corresponding to a section of the gastric zone. At the operation there was found a small gall-bladder contracted about numerous stones and dense pericholecystitic adhesions which kinked the pylorus to an acute angle.

In visible gastric peristalsis from various causes, we have at times observed the anterior part of the gastric zone appear, and disappear when the peristalsis ceased. We have not found gastric zones in patients who had gastric symptoms (nausea and vomiting) in the course of acute abdominal affections, such as appendicitis, cholecystitis, etc., but the zones corresponding to the diseased viscera were present. In this connection the zones have sometimes been of diagnostic value, as in the case of a female, aged fifty years, who was admitted to the hospital on account of repeated vomiting, with generalized abdominal pain and tenderness. The search for skin hyperalgesia revealed not a gastric zone, but one for the uterus and adnexa. The lesion proved to be a retroflexed uterus with diseased adnexa, and the vomiting was reflex.

Before leaving the subject of gastric zones, we desire to add a remark on the subject of the so-called tender point in gastric ulcer that is often found on the back opposite the tenth dorsal vertebra. Many patients point to this as the region of greatest pain. This tender point will be found to lie within the area of gastric hyperalgesia, and to correspond to the posterior maximum of the gastric zone. This fact may be the explanation of the tenderness and pain experienced in this region by many patients with gastric ulcer.

THE DUODENUM. The duodenal zone lies between the gall-bladder and the appendix zones. It lies almost completely to the right, but in two of the patients extended slightly to the left of the anterior median line. Anteriorly it is broad; its upper limit is

about on a horizontal line midway between the umbilicus and the ensiform cartilage; its lower border is a little below the umbilicus. It extends backward and slightly upward, and narrows; at the anterior axillary line it is very narrow (about 1½ inches); it then becomes broader, and is lost about the midscapular line. It corresponded roughly to the ninth right dorsal zone of Head in the few patients we have examined.

No.	*Disease.*	*Symptoms.*	*Zone.*
1.	Perforated ulcer.	Fever, acute abdominal symptoms.	Well-defined.
2.	Bleeding ulcer.	Melena, colic, slight tenderness.	Well-defined.
3.	Bleeding ulcer.	Melena, colic, slight tenderness.	Well-defined.
4.	Bleeding ulcer (chronic).	Slight pain and tenderness.	Absent.

The diagnostic significance of Head's zones was well illustrated in Case 1:

Perforated Duodenal Ulcer, with Hyperalgesic Zone Corresponding to the Duodenum. The patient entered the hospital with a three days' history of abdominal cramps, which became localized in the right half of the abdomen; at the onset he vomited and was constipated. A similar attack four weeks before had been treated as appendicitis. On admission, temperature, 101°; pulse, 100. General condition fair; slight rigidity of right rectus muscle; moderate tenderness a little below and to the right of the umbilicus. The patient was supposed to have a mild appendicitis. There was indistinct hyperalgesia on the right side above the navel. The following day the temperature was normal, and the patient complained of cramps in the right lower abdomen. Physical signs unchanged, except that a well-marked duodenal zone was now present. Although the zone of hyperalgesia was recognized as duodenal, the diagnosis of appendicitis was adhered to. The operation, on the following day, revealed a small perforation of the duodenum from an ulcer in its descending portion with numerous adhesions around it.

Gall-bladder and Liver. According to our experience, a zone is present in acute affections of the gall-bladder more often than in any other acute intra-abdominal affection. In these cases the Head zone has often been a valuable diagnostic aid. In many cases an enlarged, tender, and palpable gall-bladder makes the diagnosis easy, but the recognition of the disease is often difficult or impossible in stout patients without jaundice, with marked abdominal distention and rigidity. These patients may refer their pain to the right lower abdomen, and may have their tenderness in this region. Acute intestinal obstruction, acute pancreatitis, or acute appendicitis are diagnoses often made. In some patients the presence of a zone of hyperalgesia has been the only localizing sign.

The gall-bladder zone lies in the right half of the abdomen, above the level of the umbilicus. The complete zone starts exactly at the median line in front, extending from some distance below the

xiphoid to a short distance above the navel. Tracing it backward, it slants obliquely upward and becomes narrow, passing partly over and partly below the costal arch. It is narrowest at the midaxillary line, where it is about two inches wide. Posteriorly it becomes broader, and at the spines it is about as wide as in front. In some cases, more or less of the anterior portion only has been present (maximal area).

In 21 cases of acute cholecystitis a zone was present eighteen times. The complete zone was present eleven times, the anterior part alone eight times. The zone was present four times in 5 cases of gangrenous cholecystitis; it was found in all 3 cases of empyema, and in both cases of acute cholecystitis with seropurulent peritonitis that were examined.

In the following illustrative cases the zone was an important diagnostic aid:

Acute Cholecystitis and Cholelithiasis; Diagnosis impossible on Account of Delirium. Female, aged seventy years, admitted with a three days' history of general abdominal cramps, never localized; vomiting and fever. On admission the patient was very delirious; the abdomen was everywhere rigid, and seemed to be everywhere tender. Temperature, 105.4°. There was a marked objective anterior zone for the gall-bladder, and this was the only means of locating the lesion. The operation was done under local anesthesia, and revealed acute cholecystitis with pericholecystic abscess, due to calculi. If general anesthesia had been employed, palpation of the enlarged gall-bladder might have been possible, but because of the patient's poor condition, local anesthesia was used.

Acute Gangrenous Cholecystitis Presenting the Symptoms of Acute Intestinal Obstruction. Female, aged forty years, with four days' history of severe epigastric cramps, persistent vomiting, absolute constipation. Enemas ineffectual. Under observation, patient vomited feculent material. The abdomen was markedly distended, rigid, and very tender in its entire upper half. No mass. Complete gall-bladder zone. Acute gangrenous cholecystitis was found at operation.

In a second case, similar to this one, there was a marked anterior zone. A third case, however, with similar symptoms, had no zone.

Acute Gangrenous Cholecystitis with Reflex Anuria in a Patient with Old Renal Disease, Simulating Pyonephrosis. In a male, aged forty-three years, there was a two years' history of a right kidney disease, with occasional attacks of renal colic and pyuria; four days before admission severe pain in the right upper abdomen, vomiting, and diminution of urine. These symptoms persisted, the pain radiating to the right flank, the vomiting frequent, and the urine scanty and turbid. On admission, moderate tenderness in the entire right upper quadrant of the abdomen, marked rigidity of

the right rectus, especially in its upper half; no mass. Neither kidney palpable, but palpation for the right kidney very painful. Temperature, 103°. Urine slight in amount (7 ounces in twenty-four hours), full of pus, albumin, and casts. Moderate œdema over both tibiæ. There was a marked complete zone for the gall-bladder. The clinical diagnosis was pyonephrosis with partial reflex anuria. The day after admission, however, the rigidity had partly disappeared and an enlarged, very tender gall-bladder was palpable. The zone persisted. Temperature remained high, and the patient was operated on and an almost completely gangrenous gall-bladder was found. The infection from the cholecystitis had probably interfered with the function of the kidneys, one of which was seriously damaged. This view was borne out by the post-operative course; after a few days the patient passed much larger quantities of urine.

In the less acute affections of the gall-bladder the zone is often present, but is not of such diagnostic value, because there is less rigidity of the abdomen and more localization of the symptoms. However, we have seen a number of patients at the end of an attack, or after an attack, in whom the presence of the zone has materially helped us to make the diagnosis. The following is an example:

Calculus in the Cystic Duct, with a History of Attacks Diagnosticated as Appendicitis. A boy, aged twenty years, was admitted to the hospital with the history of an attack of right iliac pain and vomiting two years before. His present attack began four days before admission, with severe non-radiating pain in the right lower abdomen. No vomiting, no urinary symptoms, no jaundice. Twenty-four hours before admission the pain had subsided, and at the time of admission there was no pain. The physical examination was negative. There was a moderately developed anterior zone for the gall-bladder, of typical shape. Previous attacks had been diagnosticated as appendicitis. At the operation the appendix was normal; the gall-bladder was small, contained a large stone lodged in its neck, with numerous pericholecystic adhesions.

In chronic cholecystitis due to cholelithiasis, zones are often present, although diagnosis without them is usually easy from the characteristic history. Some of the cases, however, present a history that is purely gastric, and, if a zone is present, it may aid in the differential diagnosis. We have examined 19 cases of chronic cholecystitis and cholelithiasis that entered the hospital with histories of previous attacks; 11 of these had zones, mostly of the incomplete anterior variety.

An illustrative case with a gastric history:

Chronic Cholecystitis, with Vomiting and Epigastric Distress. Female, aged thirty-eight years, had for two years frequent attacks of nausea and eructations after eating, and occasionally vomiting. There was constant dull pain in the epigastrium. On two occasions

there were sharp sticking, non-radiating epigastric pains. The physical examination and gastric findings were negative. At the first examination there was no zone. On the fourth day of observation the patient "ate something that did not agree with her," and had more epigastric pain than usual; there was now present an anterior, moderately developed gall-bladder zone. The operative finding was a markedly thickened gall-bladder, with adhesions that stretched to the duodenum, and several large calculi.

In pancreatic disease with dilated gall-bladder a zone for the gall-bladder is sometimes present. We have seen 5 cases of carcinoma of the head of the pancreas with dilated gall-bladder, in 2 of which an anterior gall-bladder zone was present. Two cases of chronic pancreatitis with distended gall-bladders were seen; both had anterior gall-bladder zones. We do not know if pancreatic zones exist. In several cases of acute and subacute pancreatitis that we have studied there was no skin hyperalgesia. In abscess of the liver, in acute congestion of the liver (from cardiac disease, etc.), and in cirrhosis of the liver, we have found in some of the cases hyperalgesia over the lower right chest. The areas of hyperalgesia were very irregular, and corresponded to no zone.

Kidney and Ureter. The kidney zone is wide at the posterior median line, where it begins, and gradually narrows anteriorly. Its greatest breadth is at the spinal column. It narrows to make a triangular area, with a rounded apex, situated a little to that side of the anterior median line on which the zone lies. We have never seen the kidney zone quite reach the anterior median line. Each zone is strictly limited to its half of the body. There is no difference in contour between the right and left kidney zones. The kidney zones are complicated by the additional ureteral zones that are present in certain cases. The ureteral zone springs, so to speak, from the lower margin of the kidney zone at the anterior axillary line. In an average adult it is about three inches wide at this beginning. It narrows in its downward course, and passing obliquely downward and forward, it terminates on its side of the penis and scrotum in the male; the labia in the female. After the first narrowing it widens again well below the umbilical level. In the male, after this swell, it can be ascertained that the zone spreads fan-shape to the anterior median line over the pubic area and its half of the scrotal and penile skin. There are anterior and posterior kidney maximal areas. The ureteral zone seems to be made up of a series of maxima. The kidney and ureteral zone is most often present, as in the other intra-abdominal affections, in the presence of pain and tenderness.

We have examined 14 patients with renal calculus, and have found a more or less marked zone six times. In most of the cases in which the symptoms were slight no hyperalgesia could be demonstrated. Two of four cases of pyelitis had zones, as had one patient

with an acute pyelonephritis; one of infected hydronephrosis due to calculi, one of septic infarct in acute endocarditis, one of pyonephrosis. The more acute the renal affection, the more apt is there to be a cutaneous hyperalgesia. Thus we have not found a zone in the large majority of patients with tumors of the kidney, with the exception of one case, in which the operation showed that there was a large fresh hemorrhage into the tumor.

When a calculus passes into the ureter from the kidney, the kidney zone is apt to disappear and a ureteral zone develop. We have observed this in several instances, and have been able to follow the passage of the calculus along the ureter by means of the skin hyperalgesia. Of 8 cases of stone in the ureter, there was a more or less well-marked zone in 6. In a case of rupture of the kidney, there developed a well-marked ureteral zone after a severe colic. The colic and zone disappeared after the passage of a blood clot. The diagnostic value of localized areas of skin hyperalgesia in kidney and ureteral affections is not as great as in other abdominal affections, but in some patients it has had practical usefulness. In one case the findings were of considerable interest:

Calculous Anuria; Left-sided Pain; Right-sided Zone. A man was admitted to the hospital with a three days' history of pain in the left flank and almost complete anuria. On admission he was drowsy, and did not complain of pain. There was a marked objective zone for the right kidney. At operation there was found a double calculous pyonephrosis; the left kidney was atrophic and did not contain any urine; the right kidney was less diseased, was the seat of recent inflammation, and contained some urine.

Experience may show that in cases of this kind the zone may help in determining which kidney should be operated upon.

The presence of a ureteral zone on the right side has helped us to distinguish ureteral calculus from appendicitis in several cases, but our experience has been too small for any positive statements as to its value. We believe that the absence of a ureteral zone and the presence of an appendix zone make the diagnosis of a ureteral calculus at least doubtful, even though there are well marked urinary symptoms. On the other hand, the presence of a ureteral zone must make one suspect trouble in the ureter, in spite of absence of urinary symptoms. In this connection the following case is of interest:

Suspected Ureteral Calculus on Account of Suspicious X-ray Shadow and Red Blood Cells in the Urine; Well-marked Appendix Zone; Appendix Found Diseased. A man, aged forty-four years, gave a history of sharp pain in the right lower abdomen for three days. On admission there was tenderness in the right iliac fossa, slight rigidity of the rectus, temperature, 101°. There was a moderately developed anterior zone for the appendix. The urine contained a few casts and pus cells. During the four succeeding days

there was pain at times. The zone disappeared in two days. After cystoscopy and ureteral catheterization, there were a few red blood cells in the urine. *X*-ray showed a "suspicious shadow" in the lower part of the right ureter. The ureter was exposed by the extraperitoneal route, and was found empty. The peritoneal cavity was opened, and a very adherent, acutely inflamed appendix was removed.

VERMIFORM APPENDIX. The zone begins at the median line in front, sometimes a little to its left, from a point a short distance below the umbilicus to one equally distant from the symphysis pubis. It narrows toward the anterior axillary line to a width of about two inches (average adult). From this line it widens and spreads to the posterior median line from the eleventh dorsal to the second lumbar spines (approximately). At the anterior median line there is often a tongue-like downward extension of the zone (see diagram). There is an anterior maximal area which is sometimes present alone. We have not seen posterior maxima. It may be that the "appendix" zone is really an "appendix and cecum" zone, because the cecum is so frequently involved in appendicitis. Sometimes, when an ice-bag has been employed over the appendix region, only the posterior half of the zone is present.

Diagnosis has been aided in a considerable number of the patients by the presence of the zone, especially in that large class of acute cases in which the abdomen is rigid and there is no palpable mass. The zone has been of the greatest value in helping to differentiate between diseases of the appendix, on the one hand, and those of the gall-bladder or right uterine adnexa, on the other.

We have already stated that the absence of a zone is of no significance. But if a patient complains of symptoms which resemble appendicitis, and a zone is not present in the right lower abdomen, it is well to look elsewhere for hyperalgesia. Thus, we have seen several cases of beginning pneumonia that had considerable pain, tenderness, and rigidity in the right iliac region, in which hyperalgesia over the thorax first led to careful examination of the lungs.

Careful examinations in a large number of cases of acute and chronic appendicitis have given the following results: In the majority of cases of chronic appendicitis, or, more properly, cases of appendicitis admitted for operation in the interval, we have found no zone. In some patients, who entered the hospital with the history of a recent attack, a zone of hyperalgesia could be demonstrated. We tabulate the acute cases:

	Cases.	*Zone present.*	*No zone.*
Acute appendicitis	20	14	6
Acute appendicitis with peritonitis	21	17	4
Acute appendicitis with abscess	35	21	14
Acute appendicitis with abscess and peritonitis	15	12	3
Acute appendicitis, gangrenous and perforating	15	13	2
Empyema	8	5	3
Total	114	82	32

Thus, in over 70 per cent. of the patients with acute appendicitis the characteristic hyperalgesic zone was present. It was complete, extending from the median line in front to the median line behind, and with characteristic outline in the greater number of the cases. In more than 50 per cent. of the patients with an abscess and a history of more than six days' duration the zone was absent. If these cases are excepted, the "appendix zone" was present in almost 80 per cent. of patients with recent acute appendicitis.

In the following are given short histories of some cases of special interest:

Acute Appendicitis (Retrocecal). Three days' history of severe pain in the right upper abdomen, radiating to the right flank, one chill, and fever. Rigidity of the whole right rectus. Marked tenderness at two points: one in the right hypochondrium in the axillary line, the other at McBurney's point. Markedly developed anterior appendix zone. The appendix found adherent to the anterior surface of the kidney.

Acute Appendicitis, with Jaundice. Five days' history of severe cramps in the right half of the abdomen, that localized a little below the umbilical level. The right rectus was equally rigid above and below. No mass. Moderate fresh icterus of the skin and conjunctivæ. Markedly developed anterior appendix zone. At operation, liver and gall-bladder were normal. The jaundice was due either to toxemia or to gastroduodenitis.

Acute Appendicitis, with Appendix Zone and Zone for the Right Adnexa, which were Secondarily Inflamed. On admission there was a twenty-four hour history of pain in right lower abdomen, and vomiting. There was no fever. Moderate tenderness over McBurney's point. No zone. The next day, the symptoms persisting, there was a markedly developed complete appendix zone. That evening a zone for the right uterine adnexa developed in addition to the appendix zone. At operation the appendix overlay the right tube, which was acutely congested. Two days after operation the zone for the right adnexa, which began to fade twenty-four hours after operation, was gone.

Acute Gangrenous Appendicitis; Chronic Pyosalpinx. After a puerperal infection two years ago there had been pain in the right lower abdomen, radiating down the thigh, leukorrhœa, and dysmenorrhœa. Occasional exacerbations of the pain, with chilly sensations and fever. Three days before admission there was an attack of severe pain in the right lower abdomen, and vomiting. Marked tenderness in the right iliac fossa and marked rigidity of the right lower rectus. No mass felt through the abdomen. By vagina there was an elastic, slightly tender mass in the right vaginal vault. Moderately developed complete appendix zone. At operation, in addition to the appendix lesion, there was an old adherent pyosalpinx.

Acute Appendicitis in the Puerperium. Six weeks before admission patient was delivered of a child. During the puerperium there was fever and pain in the right lower abdomen. After the two weeks' puerperium pain in the right lower abdomen continued. Three days before admission pain became more marked, cramp-like, and accompanied by fever. There was marked tenderness and rigidity of the right lower abdomen. Marked tenderness in the right vaginal vault. Moderately developed complete appendix zone.

Acute Appendicitis; General Purulent Peritonitis. Symptoms began four days before admission, with general cramps that never localized, and vomiting. The patient entered the hospital in a moribund condition, with the signs and symptoms of an advanced peritonitis without any focal signs. There was a moderately developed anterior appendix zone. Patient was not operated on; the postmortem showed the lesion.

In the general discussion of hyperalgesic zones attention was called to the significance of *sudden appearance and disappearance of zones,* with persisting symptoms. We summarize here our experience in appendicitis:

Gangrene of the Mesenteriolum of the Appendix. For four days there had been slight pain in the right lower abdomen. On admission temperature and pulse were normal; there was no pain, and only very slight tenderness in the right iliac region. There was a markedly developed complete appendix zone. The next day chill; temperature, 104.2°; abdominal signs unchanged. The zone had disappeared. Immediate operation disclosed an acutely inflamed appendix, with complete thrombosis and gangrene of the mesenteriolum.

Ruptured Appendiceal Abscess. Patient entered the hospital with a small, very tender mass in the appendix region. There was a moderately developed anterior appendix zone. Patient complained of slight cramps in the right lower abdomen. Two hours after admission the cramps had ceased, but the patient looked much worse, and the whole abdomen was rigid. The zone had disappeared. At the operation, the abscess was found discharging pus into the general peritoneal cavity.

Ruptured Appendiceal Abscess. On admission, patient complained of slight pain in the right lower abdomen, where there was an egg-sized, very tender mass. There was a markedly developed complete appendix zone. One-half hour later cramps became generalized, and the abdomen was rigid, and there was only a slightly developed irregular appendix zone. Findings at operation as in the former case.

Ruptured Appendiceal Abscess. On admission, an orange-sized mass, with slight rigidity of the lower right rectus. Patient complained of very slight pain. There was no zone. Three hours later there was more pain of crampy character; otherwise the symp-

toms and signs were unchanged. A moderately developed anterior appendix zone had appeared. At operation the abscess was leaking pus at one point into the general peritoneal cavity.

Appendicitis in Typhoid Fever. We have seen four cases of acute ulcerative and one case of subacute appendicitis that developed in the course of typhoid. All of them except one of the acute ulcerative cases had well defined appendix zones. All of the cases had pain and tenderness. In one of them the nature of the zone helped in differentiating from typhoid perforation.

INTESTINES. Irregular areas of hyperalgesia were present in some of the cases of intestinal tumors and of intestinal obstruction that we have studied, but they have no uniform shape and do not seem to be of any value. The only intestinal lesions in which there was uniformity in the zones were ileocecal tuberculosis and perforation of the ilium.

Ileocecal Tuberculosis. The zone that we have seen in these cases was a large area of hyperalgesia occupying the whole right lower abdomen down to Poupart's ligament, often extending a little to the left of the median line, and posteriorly becoming lost about the posterior axillary line. In nine cases the zone was present five times. In one case with abscess formation and a three weeks' history, the zone was the only finding that militated against the diagnosis of appendicitis abscess. In another case, with vague pain and melena, the zone gave the first suggesion that the lesion—induration of the iliocecum and adhesions—was in the right lower abdomen.

Perforations of the Ileum. In several cases of free typhoid perforations of the ileum a zone was not present. All the patients were delirious, and at operation there were gas and feces in the general peritoneal cavity. We saw two slow typhoid perforations, both presenting marked zones; their histories are very much alike, and we give one:

During the whole third week of the disease the patient complained of colicky pain in the right lower abdomen, which on the day of admission (twenty-third day of illness) had become more marked. The patient was delirious. The whole abdomen was rigid. Exceedingly marked objective zone, resembling the zone in ileocecal tuberculosis, but extending more to the left of the median line. At operation the lower ileum was adherent and feces were present only in the pelvis.

We saw only one case of perforated tuberculous ulcer of the lower ileum that presented a history like appendicitis, and in which the only finding against appendicitis was a zone like that of the slow typhoid perforations. This, too, was a slow perforation, the loop of gut involved being found wrapped in omentum.

UTERUS AND ADNEXA. Head describes differences between the zones for the uterus, the ovary, and the tube, which we have been

unable to verify. The zone for the right adnexa lies on the right half of the median line; that of the left adnexa on the left half; the zone for the uterus is a combination of the two.[11] There is no difference between the zones for the right and left adnexa. Beginning some distance above Poupart's ligament, the upper margin of the zone runs parallel to it, and pursues this obliquely upward course to the spine of the second lumbar vertebra (approximately). The lower margin is a long, tongue-like process that extends half-way down the thigh on its inner aspect. The lower margin, as it passes a short distance below the anterior superior spine of the ileum, approaches the upper, the average breadth of the zone here being three inches. The lower border then passes horizontally backward over the buttock to reach the posterior median line partly over the sacrum. Sometimes the upper half of this zone is better developed, sometimes the lower; these may be considered maxima.

Diagnosis in the diseases of the uterus has not been aided by the presence of a zone, and we will therefore dispose of this heading briefly. In about half of the cases of dysmenorrhœa and of endometritis with pain the zone was present. Some of the cases of retroflexion, retroversion, anteflexion, and prolapse showed the zone. It was present in the five cases of uterine polyp that we observed (all of them had pain). It was not present in tumors of the uterus, except in a few cases.

In diseases of the tubes and ovaries, especially those of the right side, the zones have been of diagnostic value.

	No. of cases.	*Zones present.*
Pyosalpinx, acute	9	9
Pyosalpinx, acute, double	3	2
Salpingo-oöphoritis	7	4
Salpingo-oöphoritis, double	5	4
Ovarian abscess	3	2
Ovarian cyst, twisted	3	3
Ectopic gestation	9	5
Total	39	29

A large number of cases that presented few or no symptoms have not been included in the above list, because the majority had no zones. There were no zones in a large number of patients with tumors and cysts of the ovary.

We present some illustrative cases in which the presence of the zone aided diagnosis:

Bilateral Acute Suppurative Salpingitis; Seropurulent Peritonitis. Physical signs of appendicitis, with a small mass low down in the right iliac region. Marked zone for the right, less marked zone for the left adnexa. At operation, the right tube showed the

[11] It is very difficult to determine a separate zone for the uterus, because in so many cases in which the uterus is diseased the adnexa, too, are diseased.

more marked lesion, the palpable mass being made of omentum that enwrapped it.

Right Suppurative Salpingitis; Diffuse Purulent Peritonitis. The patient, aged fifty-five years, entered the hospital in a delirious condition. Her history indicated appendicitis. The abd men presented the signs of a generalized peritonitis; no focal signs. There was a marked zone for the right adnexa.[12]

Right Pyosalpinx; Streptococcic Peritonitis. Abdomen rigid and tender throughout. History suggested perforated gastric ulcer. Marked zone for right adnexa, slight zone for left adnexa. Vaginal examination negative. At operation the left tube was deeply congested; contained streptococci. Pus from right tube showed streptococci.

Left Twisted Ovarian Cyst Lying on the Right Side. Three days' history in a patient, aged seventeen years, suggesting appendicitis. Marked tenderness and slight rigidity of the right lower abdomen. Tenderness and fulness on the right side by rectum. Marked zone for the left adnexa. At operation the cyst, springing from a long pedicle, lay behind the right uterine adnexa. The correct diagnosis in this case was suggested by the Head zone alone.

VII. CONCLUSIONS.

1. We agree in the main with the statements of Head, that there are present, in many affections of the abdominal viscera, constant and definite areas or zones or cutaneous hyperalgesia.
2. These zones may vary somewhat in extent and in outline, but they have a characteristic location.
3. The presence of a characteristic zone is an evidence of an affection of the corresponding abdominal viscus, although not of necessity the affection which is causing the symptoms.
4. The zones are present in a large percentage of patients with acute affections of the appendix, of the gall-bladder, of the uterine adnexa, and are of considerable value in the diagnosis of these acute affections.
5. Zones are frequently present in acute disease of the other abdominal viscera, and when present aid in making the correct diagnosis.
6. Cutaneous hyperalgesia may appear early in acute abdominal disease. Its presence is no index of the gravity of the lesion. Its sudden disappearance may be of grave significance.

[12] At the postmortem examination there were streptococci in the small amount of pus in the right tube. Cultures from the vagina and from the uterus showed streptococcus. Cultures from the left tube, which contained no pus, were sterile. In the left horn of the uterus was a polyp that completely blocked the uterine opening of the left tube. The case was evidently one of ascending infection. The findings account for the absence of a zone for the left adnexa.

7. In the absence of all other localizing signs or symptoms, the zone may indicate the organ that is affected. In most instances, however, it must not be used to make the diagnosis, but only as a diagnostic aid, to substantiate conclusions reached from a consideration of all the symptoms and signs.

TUMOR OF THE GASSERIAN GANGLION.[1]

A REPORT OF TWO CASES, WITH NECROPSY.

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Tumor arising in the Gasserian ganglion or having its chief clinical manifestations in disturbance of this ganglion is fortunately rather rare, but doubtless far more common than is generally believed. Brain tumor is always serious in its symptomatology, but when the Gasserian ganglion is implicated the pain is usually intense. The first case of tumor in this region recorded in this country, and the second case on record in which operation was performed, is that reported by Dercum, Keen, and Spiller (1900). Since then two cases with necropsy, in one of which operation was done, have come under my care.

Case I.—A. K., aged twenty-five years, was referred to the University Hospital by Dr. H. S. Crouse, of Littlestown, Pa., March 4, 1907. Dr. Crouse stated that the patient first had paralysis of the right fifth nerve, with severe pain; the right optic nerve was then implicated causing blindness in the right eye, later the left optic nerve became affected causing complete blindness. Then the left arm became paretic. At times the mentality was much impaired, but only when the pain in the head was severe.

The history as obtained after the patient entered the hospital is as follows:

Chief Complaints. Blindness, intense headache, vomiting.

Social History. Patient is a brick layer and stone mason. He is unmarried. He uses beer and whiskey, sometimes to excess. He chews tobacco rather freely. He had gonorrhœa about a year ago, but has no history of syphilitic infection.

Family History. Father and mother are living. Two brothers and three sisters are living and well; one sister died of eclampsia.

[1] Read by invitation at a meeting of the St. Louis Surgical Society, May 29, 1908.

The patient says the members of his family are all more or less "nervous." No family history is obtained of tuberculosis, malignant, cardiac, or renal disease.

Previous Medical History. Is negative except that he has had a number of attacks of tonsillitis.

Present Illness. The patient is in an advanced stage of mental hebetude, probably as a result of bromism, and his statements are vague and unsatisfactory. He says that last winter he began to have weakness and soreness about the articulation of his jaw (whether the right or left side is not stated), the soreness afterward spreading to his head where it has persisted ever since. About two months ago blindness developed in the right eye and this was followed about two weeks later by blindness in the left eye. During this same period he has vomited a number of times. He is not able to walk unless some one leads him. He believes this inability to walk is caused by his blindness. His general health has not suffered much. Headaches of late have been very severe.

Physical Examination. A rather poorly developed and emaciated male subject, looking considerably older than his given age of twenty-five years. Skin is covered with a profuse, deeply colored, red eruption, probably the result of bromides. He has no noteworthy glandular enlargement. Pulse is regular, volume fair. Chest is poorly developed; expansion is fair and equal on both sides. Heart and lungs negative. Abdomen soft and symmetrical. Abdominal organs negative.

March 6, 1907. Examination by Dr. Spiller. The left pupil is much larger than the right. Both irides are immobile to light; slight contraction is obtained of each pupil in attempt at convergence. He says he sees light with each eye separately. He wrinkles the forehead well, closes the eyelids, shows the teeth, and draws up each corner of the mouth well, therefore he has no involvement of either facial nerve. Tactile sensation is completely lost in the entire distribution of the right fifth nerve, provided no pressure is produced. Sensation of pain is lost in the same distribution. Sensation is preserved along the border of the lower jaw in the distribution of the cervical nerves. The conjunctiva and cornea are anesthetic in the right eye but not in the left eye. A piece of paper put far up the right nostril is not felt unless pressure is produced, and causes no lachrymal reflex. The jaw goes distinctly to the right when the mouth is opened. The right tonsil is swollen and the uvula is absent. Sensation of the left nostril is normal.

He is distinctly deaf to the voice in both ears. The soft palate moves very imperfectly on the right side. The sense of smell is greatly impaired on each side. The tongue is protruded straight. Taste for salt and sugar probably is lost on the front and anterior part of the tongue. This may have been only on the right side. The grasp of each hand is fair. The upper limbs move freely in

all parts; biceps and triceps tendon reflexes are not distinct on either side. Sensations of touch and pain are normal in each upper limb. Movements in the lower limbs are free in all parts. Patellar tendon reflex and Achilles tendon reflex are lost on each side. Babinski's reflex is not obtained; the toes are not moved distinctly in either direction. Sensations of touch and pain are normal in each lower limb. The gait and station of the patient are very ataxic; he has marked sway with the feet close together.

Examination by Dr. de Schweinitz. Palpebral fissures are equal in width. Left eye is slightly divergent. Movement of the left external rectus is preserved. Movements of internal, superior, and inferior recti are markedly limited. No wheel movement is obtained.

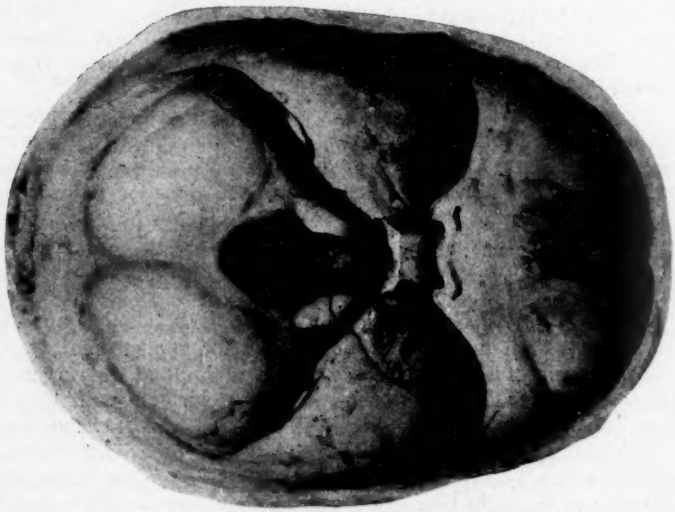

FIG. 1.—Diagram showing the position of the tumor in Case I.

There is loss of movement of the external rectus of the right eye and marked limitation of movements of the superior and inferior recti, with almost lost internal rectus movement. Extensive double optic neuritis is found with large retinal hemorrhages on the right side.

April 11. Last night the patient became unconscious; for the last few days he has not seemed to be quite so well. He was transferred to Dr. Frazier's service for operation. A lumbar puncture was made and the cerebrospinal pressure was found to be equal to 27 mm. of mercury (351 mm. of water), and about 15 c.c. of spinal fluid was removed until the pressure was down to 5 mm. of mercury (65 mm. of water).

A decompressive operation was done on each side of the head by

Dr. Frazier just above the ear, in order to relieve the intracranial pressure. The brain bulged much on the right side. The patient died April 12, about 2 P.M.

The brain was removed by me. The right temporal lobe was soft and tightly adherent to the floor of the middle cerebral fossa, and was loosened with much difficulty. A tumor was seen holding the base of this temporal lobe to the dura, and the lobe was removed by cutting through the tumor. The latter seemed to grow from the dura, was most developed at the seat of the right Gasserian ganglion, and nothing was seen of this ganglion, as its position was occupied by the tumor. The tumor covered the floor of the middle fossa in the region of the middle lacerated foramen, foramen ovale, fora-

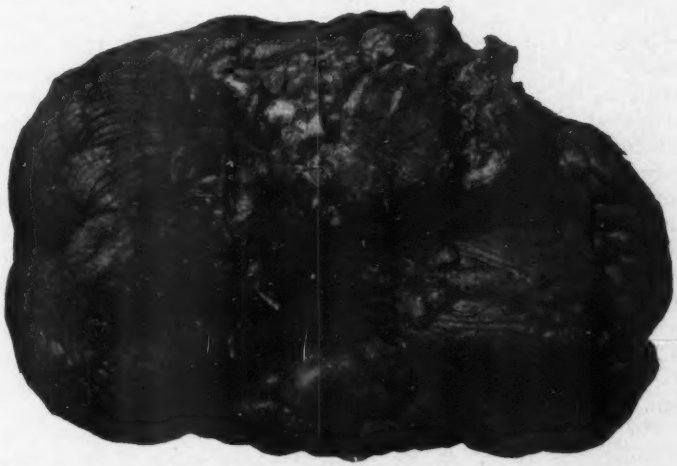

FIG. 2.—Photograph of the brain removed in Case I. The right temporal lobe is invaded by the tumor. A small tumor of nervous tissue containing nerve cells and medullated nerve fibers is seen on the right side of the cerebellum at the exit of the seventh nerve.

men rotundum as far forward at the right sphenoidal fissure, also the inner part of the petrous portion of the temporal bone in the posterior fossa internal to the internal auditory meatus, and extended over the basilar process as a flat growth as far as the left posterior clinoid process. A round tumor was found invading the base of the right temporal lobe (as described above), and was detached from the lobe in removing the brain, as the lobe was soft. The tumor was firm and measured about 4 cm. in each direction, and extended about 3 cm. into the brain. The right fifth nerve was enveloped in the tumor at its entrance into the pons, and the right third, fourth, and sixth nerves also were caught in the tumor. The tumor did not seem to extend quite far enough to the left to catch the left

third nerve, but came very close to it. It must, however, from the symptoms, have involved this nerve. The bone of the skull did not seem to be implicated. A small hard mass was found at the under part of the right cerebellar hemisphere. The tumor was flat and thin except in the middle cranial fossa.

Microscopic Examination. The tumor does not extend into the base of the brain except very slightly at the side of the pons. It covers the pons exactly at the entrance of the fifth nerve into the pons, so that the fibers of this nerve become a part of the tumor immediately beneath the pons. The nerve is completely degenerated at its entrance, as stained by the Weigert hematoxylin method, but the Marchi stain shows numerous fibers in the process of degeneration of the myelin sheaths. The pyramidal tracts are not degenerated. The cells of the motor nucleus of the right fifth nerve are swollen and have peripherally placed nuclei. The sensory nucleus stands out prominently by its yellow color in the Weigert stain, owing to the paucity of medullated nerve fibers; its cells appear somewhat shrunken and some have peripheral nuclei. A considerable mononuclear cellular infiltration is seen about some of the vessels of the pons. These may be cells from the tumor, but they appear somewhat smaller. The fibers of the motor root within the pons show partial recent degeneration by the Marchi method. The pia over the pons presents a distinct round-cell infiltration, suggesting the possibility of syphilis; the pia over the optic chiasm also shows slight round-cell infiltration. The spinal root of the fifth nerve shows degeneration by the Marchi method in the medulla oblongata, more intensely in its posterior part. A transverse section was made through the right optic nerve; it shows much degeneration.

The tumor consists of groups of cells separated by bundles of connective tissue. In the dura from the region of the tumor the cells form sometimes elongated masses as seen in an endothelioma.

The small tumor found on the cerebellum at the exit of the seventh nerve, is of very peculiar structure. It appears to have originated in the choroid plexus, and in one portion shows the convolutions of this plexus. It is composed chiefly of neurogliar tissue and contains nerve cells scattered through it irregularly; some of these resemble the cells of the spinal ganglia, others are like the cells of the anterior horns, except that dendritic processes are not so distinct though occasionally they are seen. The tumor is vascular. The cells contain chromophilic elements, though these are not so numerous as is usual in nerve cells. The tumor also contains medullated nerve fibers, as shown by the Weigert hematoxylin stain. These are chiefly at the periphery, but here and there within the substance of the tumor one or two medullated nerve fibers may be seen.

CASE II.—McC., male, aged forty-three years, was referred by Dr. Biddle to Dr. de Schweinitz's service in the University Hospital, and examined by Dr. Spiller February 20, 1906.

He had had severe pain variable in intensity in the head about four months, worse at night, and controlled only by morphine. The pain was in the distribution of the first and second divisions of the right fifth nerve and slightly in the third division. No dizziness was felt. He had been exposed to syphilis about a year previously, and it was uncertain whether he had contracted the disease or not. He complained of diplopia. The hearing had not been so good in the right ear as in the left about two years, but he had had repeated colds. The right side of the head was said to perspire much less freely than the left. The right pupil was smaller than the left. Reaction to light was very sluggish, especially in the right eye; reaction in accommodation was prompt. He was unable to rotate the right eyeball outward, and the right eyeball was slightly retracted; the right palpebral fissure was smaller than the left. The right masseter muscle did not contract so forcibly as the left, and the jaw deviated a little to the right when the mouth was opened.

Gait and station were normal. The bladder and rectum were not affected. The muscular strength was not diminished. The patellar reflex was normal on each side. No objective sensory changes were detected, except that light touch was felt on the right side of the head and face as pain, while heavy pressure was less painful.

A hard, swollen gland was found in the left side of the neck at the anterior border of the sternocleidomastoid muscle.

Dr. Randall found that the reduction in hearing in the right ear was slight, and was caused in part by middle ear disease. The bone conduction was not so good as it ought to be, and a nerve lesion could not be excluded, but the impaired conduction was no more than is common with such old tympanic deafness.

An examination of the eyes in Dr. de Schweinitz service was made February 20, 1906. O.D., $\frac{6}{12}$, with correction, $\frac{6}{12}$. O.S. $\frac{6}{9}$, +, with correction $\frac{6}{7.5}$. Hyperemia of tarsal and bulbar conjunctiva. Internal squint O.D., limitation of movement of O.D. toward right. Pupil of O.S. larger than that of O.D. Paralysis of external rectus of O.D. Both irides respond to light. Ophthalmoscopic examination: O.D. oval disk, temporal half slightly pallid. Low H. O.S. oval disk. Nerve of good tint.

Dr. Harland, in Dr. Grayson's clinic, reported March 17, 1906: He has no sinus pain or tenderness. Nasal obstruction has existed three months. The septum is deviated to the left. Far back on the left side is a soft, bleeding mass, and a similar mass is found in the vault of the pharynx on the right side. The small mass in the vault of the pharynx hanging down on the left side bleeds to the touch. The lateral folds are thickened. The larynx is congested, but not paralyzed. The diagnosis was sarcoma of the nasopharynx.

Dr. Frazier, at my request, removed the enlarged gland of the neck for diagnostic purposes, and it was found to be the seat of an endothelioma. This was done before the report of the examination of the throat was obtained.

The pain in the right side of the head and face continued, and relief by surgical means seemed imperative. Dr. Frazier operated April 5, 1906, and exposed the Gasserian ganglion. Neoplastic tissue was found about it, a part of which with a portion of the ganglion was removed. This removal was followed by excessive hemorrhage, presumably from the internal carotid, and the operation had to be stopped. A provisional ligature was placed on the common carotid artery. The patient was not severely shocked at first by the operation, but an hour later the pulse suddenly became very rapid, reaching 160, and blood pressure became 112. By night the pulse fell to 120 and the blood pressure rose to 120. The man was comfortable the next day.

He complained frequently of pain in the distribution of the right fifth nerve after the operation, but it was not of the same severity as before the operation. Touch was not felt in the distribution of the three branches of the fifth nerve unless it were made with slight pressure, when it was recognized. The right conjunctiva was anesthetic.

May 24, 1906, the patient tried to get out of bed four times, and each time fell to the floor and had to be lifted back to bed. He was out of bed May 25, but was duller than usual. By mid-day he became dizzy while walking, and fell to the floor. He became stuporous and by night was unconscious. Respiration was somewhat labored. He died at 6.30 A.M., May 26. There was some suspicion that he might have obtained an overdose of morphine from some of his visitors.

The brain was very adherent to the dura at the base of the right temporal lobe, and a tumor mass extended from the base of the skull into the temporal lobe. The right temporal lobe was œdematous and very soft, and was torn a little in removing the brain, and still more so by handling the specimen later. The tumor mass was yellowish in color and easily separable from the brain. The brain tissue beneath was very vascular. Recent fluid hemorrhage was in the base of the skull and apparently did not come from the necropsy. One or two recent clots were in the tumor. Death possibly was from hemorrhage. The region of the right Gasserian ganglion was occupied by the tumor, and no distinct ganglion tissue could be found. The case was one of tumor of the right Gasserian ganglion, extending into the base of the right temporal lobe and into the nasopharynx.

My microscopic examination gave the following results:

Teased specimens, stained with osmic acid, of the right twelfth, right eighth, and right seventh nerves were normal. The right sixth nerve showed degenerated fibers in teased preparations.

The descending spinal root of the right fifth nerve was partially degenerated in the medulla oblongata, by the Marchi stain. The right eighth nerve, by acid fuchsin and Weigert stain, was normal. The right sixth nerve was embedded in the tumor and was partly degenerated as shown by these stains; some of the axis cylinders and medullary sheaths were much swollen. The sensory portion of the right fifth nerve was intensely degenerated, as shown by the Weigert method and also when teased and stained in the fresh state by osmic acid.

The tumor had the appearance of an endothelioma. The Gasserian ganglion was embedded in the tumor, and the nerve cells and nerve fibers of the ganglion were much degenerated. Nerve bundles in tissue from the region of the right Gasserian ganglion were intensely degenerated.

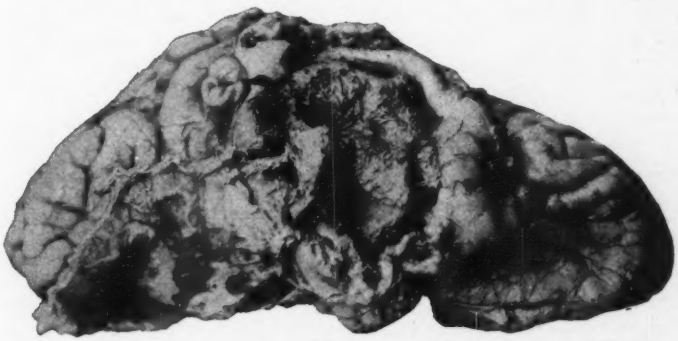

FIG. 3.—Photograph of the base of the right cerebral hemisphere from Case II, showing a condition closely resembling that of Case I.

The nerve cells of the ganglion were greatly altered; many were shriveled masses of granular pigment in which no nucleus could be detected, or if the nucleus were present it was indistinct.

The important features of Case I are: Paralysis of the right fifth nerve, with severe pain as the first symptom, then blindness of the right eye, later of the left eye, with optic neuritis, impaired mentality when the pain was severe, inequality of pupils, the right being the smaller, loss of reaction to light probably from the optic nerve disease, bilateral deafness, weakness of the soft palate on the right side, impairment of the sense of smell, loss of patellar and Achilles tendon reflexes, ataxic gait and station, weakness of the left third nerve, still greater weakness of the right third nerve, and paralysis of the right sixth nerve. The facial nerve was not affected.

The possibility of syphilis was at first considered, but later tumor of the Gasserian ganglion was the diagnosis.

The important features of Case II are: The history of a recent exposure to probable syphilis, the pain and weakness in the distribution of the right fifth nerve, impaired hearing on the right side, lessened sweat secretion on the right side of the head, inequality of the pupils, sluggish iridic reaction to light, with prompt reaction in accommodation, weakness of the right external rectus muscle, some retraction of the right eyeball, and narrowing of the right palpebral fissure. Dr. Randall's examination made the right-sided deafness of doubtful diagnostic value, but the discovery of the tumor in the nasopharynx seemed to point to intracranial tumor as the cause of the symptoms. This possibility was strengthened by the excision of the enlarged lymph gland of the neck, and the discovery of the endothelioma within it. The diagnosis made by me was tumor implicating the right Gasserian ganglion, probably endothelioma. The right sixth nerve evidently was affected. The sympathetic paralysis of the right side of the face might be explained by the lesion of the fifth nerve.

Operation did not promise much, because it was evident that the tumor was extensive, was both intracranial and extracranial, and its complete removal was impossible. The pain in the right fifth nerve distribution was so intense that relief must be obtained. Dr. Frazier accordingly operated and removed a part of the Gasserian ganglion.

In the case reported by Dercum, Keen, and Spiller,[3] enlargement of the glands of the left side of the neck, on the side of the trifacial pain, was an early sign, and some of these glands when examined were found to be the seat of endothelioma. The patient had shooting pains in the lower limbs. The patellar reflexes were lost. Pupillary reflexes were normal, there was no failure in rotation of the eyes, each disk was somewhat anemic, and there was no congestion, neuritis, or atrophy. The symptoms of intracranial disease so far as the cranial nerves were concerned were confined to the fifth nerve. The pain in the face was still intense immediately after the first operation. The only change in the objective sensory phenomena was increase in the hypesthesia, except in the conjunctiva and brow. Some time after the first operation paralysis of the left external rectus occurred. In the second operation a large portion of tumor was removed, and still the pain persisted. The entire trigeminal distribution showed increased hypesthesia. The man was still able to appreciate contact, decided differences in pressure, and differences between a spoon dipped in hot and one dipped in cold water. The cornea was absolutely anesthetic. There could be scarcely any doubt that the Gasserian ganglion was entirely removed.

Hofmeister and Meyer have recently written a paper on tumor of the Gasserian ganglion. In their case pain in the distribution

[3] Jour. Amer. Med. Assoc., April 28, 1900.

of the right fifth nerve was the first symptom, then developed weakness of the muscles of mastication on the same side, and loss in objective sensation in this distribution, right-sided choked disk, paralysis of the right third, probably of the fourth, sixth, and eighth nerves. The lymphatic glands on the right side of the neck were swollen.

So much of the tumor as could be removed was excised in this case, and pain ceased entirely, but only for about three months, and then became severe again. A necropsy was not permitted. They believe the implication of the cavernous sinus in the tumor caused the motor disturbance in the right eye and the right choked disk. They think the tumor may have grown into the orbit. From the necropsies in my two cases it seems more probable that the paralysis of the ocular nerves and the choked disks are caused in these cases by direct implication of the nerves in the tumor, and by increase of intracranial pressure, as well as by disease of the cavernous sinus. After the operation their patient was almost entirely unable to chew on the right side, light touch usually was not recognized, pin stick was recognized somewhat better without distinction of head and point.

The diagnosis of a lesion of the Gasserian ganglion is usually easy, but it may be difficult to determine whether it is syphilitic meningitis or a tumor. In the case of Dercum, Keen, and Spiller, and in my Case II, the syphilitic infection was probable. One is tempted by his desires to make the diagnosis of syphilis, knowing that for this affection relief is often obtained in mercury and iodide; whereas in tumor of this region the prognosis is very serious. Tumor of the Gasserian ganglion seems in most cases at least to be irremovable. It apparently has its origin in the dura and has the character of an endothelioma or sarcoma, the distinction between these two forms depending largely on the interpretation of the growth by each investigator. It is usually of large size, and while at first it may be confined to the region of the Gasserian ganglion, it soon extends chiefly as a flat growth, over the base of the middle fossa, possibly into the posterior fossa, and into the orbit. It has a tendency to extend into the base of the temporal lobe above it, as in my Cases I and II, without infiltrating the brain, although firmly adherent to it. This implication gives no symptoms, unless it be the cause of the loss of smell which occurred in my Case I. Loss of smell is not uncommon in brain tumor when intracranial pressure is much increased, but when the base of the temporal lobe is implicated the lesion is near the supposed centre of smell. Endothelioma arising in the dura not infrequently implicates the adjacent bone.

The diagnosis of syphilis is therefore likely to be made, because of the history of syphilitic infection in some of the cases, and because of the knowledge that this disease by the basal meningitis it produces may readily lead to symptoms of implication of the Gasserian ganglion. The mistake in diagnosis is not likely to be so serious as in

tumor of some other location in the brain, as complete removal by operation seems impracticable in most cases at least. In my Case I the pain in the distribution of the fifth nerve was not so severe as in Case II, nor as in the case of Dercum, Keen, and Spiller, and we believed that possibly a decompression, might be sufficient by relief of intracranial pressure to lessen the suffering. The man, however, lived only one day after this operation.

The swelling of the lymphatic glands of the neck from tumor is a valuable means of diagnosing intracranial neoplasm. It is not observed in every case, but was present in the case of Dercum, Keen, and Spiller; in the case of Hofmeister and Meyer, and in my Case II. It is not difficult to excise an enlarged gland, and the finding of tumor within it, endothelioma or sarcoma, is extremely indicative of brain tumor, when such symptoms as those described above are present. The glandular tumor may result from a growth in some other part of the body, but it seems to occur with sufficient frequency in tumor of the Gasserian ganglion to make its presence of diagnostic value.

In some instances the fifth is the only cranial nerve involved, as in the case of Dercum, Keen, and Spiller, and then some confusion in diagnosis with the tic douloureux may occur, especially if objective disturbance of sensation in the fifth distribution be slight, as in the case to which reference has just been made. Some disturbance of objective sensation is almost always present, the pain is felt in all three branches of the nerve nearly simultaneously, because the disease is in the ganglion in which these roots arise, and the motor branch of the fifth nerve soon becomes paralyzed. With such a symptom complex the diagnosis of tic douloureux is impossible. It is in the early stage of the symptom complex that operation on a tumor of the Gasserian ganglion is more promising, and it is possible to perform the operation while the tumor is small. In any case in which pain is felt in all three branches of the nerve nearly simultaneously and some loss of sensation is detected in the distribution of the same nerve, it is probable that the lesion is in the ganglion, and this probability is increased if paresis of the motor portion of the fifth nerve occurs. It is at this stage that we might hope to remove the tumor entirely. Pain in the fifth nerve is almost always an early symptom, and yet it may in rare instances be slight.

I[3] have studied a case in which each ganglion was embedded in and infiltrated by a soft ependymoma without distinct clinical signs of this invasion. The man had had headache only in the left occipital region extending forward to the left temporal region, and lying on the left side increased the headache. He had had also soreness on pressure over the left supra-orbital and left infra-orbital foramina, but no tenderness over any other exit points of the fifth nerves. There was never any objective disturbance of either the

[3] Amer. Jour. Med. Sci., July, 1903, and Jour. Nerv. and Ment. Dis., May, 1907.

sensory or motor portion of the fifth nerves. It is exceedingly questionable whether the headache could be attributed to implication of the fifth nerve; it was not present on the right side of the head, and on the left side it began in the back of the head and extended to the frontal region.

Recently I had a case with necropsy in which a glioma of the pons caused symptoms resembling closely those of tumor of the Gasserian ganglion. Pain was not present in the face. The absence of pain in a case such as this should suggest a glioma of the pons, which may not cause any paralysis of the limbs.

The persistence of pain after removal of the Gasserian ganglion in some of these cases is puzzling. It was exceedingly striking in the case of Dercum, Keen, and Spiller, and was observed in my Case II. Hofmeister and Meyer mention the same phenomenon in their case. They acknowledge the possibility of attributing the recurrence of this pain to conduction by the facial nerve, but they think it is more probably caused by extension of the tumor into the central stump of the fifth nerve. The anesthesia of the cornea would seem to indicate that the conduction at least by means of the upper part of the fifth nerve is destroyed, as the eyeball receives no facial fibers. It is difficult also to explain the preservation of objective sensation from peripheral stimulation. In the case of Dercum, Keen, and Spiller, after the second operation hypesthesia of the fifth nerve distribution with anesthesia of the cornea was present. This may indicate that the seventh nerve may convey sensation. In this case hypesthesia was present before the first operation, but the patient could distinguish between the point and head of a pin, and pressure sensation was everywhere well preserved. All handling of the skin of the face gave pain and there was marked hyperalgesia.

In some cases of removal of the Gasserian ganglion for tic douloureux all sensation, including that of pressure, is lost, at least for a period following the operation, but in two cases of removal of the Gasserian ganglion I[4] have observed, preservation of pressure sensation persisted with loss of other forms of sensation in the distribution of the fifth nerve. In some, if not in all, of these tumor cases in which the ganglion is implicated removal of the ganglion or a large part of it does not seem to be followed by complete loss of pressure sensation in the fifth distribution. This preservation of pressure sensation was very remarkable in my two cases, in one of which a large part of the ganglion had been removed, and was observed also in the case of Dercum, Keen, and Spiller. In the case of Hofmeister and Meyer, after the operation light touch usually was not recognized, but pin prick was felt somewhat better without distinction of head and point; this may have been caused by preservation of pressure sensation. Microscopic study of the tissue removed at necropsy

[4] Jour. Nerv. and Ment. Dis., 1906, p. 736.

in my Cases I and II showed intense degeneration by the Weigert medullary stain, of the sensory root of the fifth nerve in both cases. It is true that the Marchi stain showed many fibers in the sensory roots of both cases in the process of degeneration, but this by no means implies that these fibers were capable of conduction, as the Marchi reaction is available for tissue that has been degenerated for months.

I have for a long time believed that the facial nerve may contain some sensory fibers, and in lecturing on this subject in 1907 to the students of the University of Pennsylvania I suggested that a member of the class might make it a subject of special study. The result has been an excellent paper by R. H. Ivy and L. W. Johnson,[6] which contains the evidence pointing to this possibility.

It is unquestionably true that in some cases excision of the Gasserian ganglion causes complete loss of all forms of sensation, but this fact does not make the transmission of certain forms of sensation through the facial nerve impossible. It is not improbable that the deep sensation of the facial nerve may be temporarily interfered with by operation on the trigeminal nerve. Twisting out peripheral branches of the latter causes much swelling of the face, and probably, thereby, some impairment of the function of the facial nerve. Excision of the Gasserian ganglion causes swelling of the axis cylinders and medullary sheaths of the peripheral branches of the trigeminal nerve, and if these are intimately associated with branches of the facial nerve, this swelling may also interfere temporarily with the function of the latter. Destruction of the sensory root of the trigeminal nerve by a tumor affords better opportunity for testing the sensation of the face, than does destruction of some part of this nerve by operation, at least in the period immediately following operation. There is great need of further observation regarding the preservation of pressure sensation in relation to lesions of the trigeminal nerve.

When the pain is intense in these cases, as usually it is, division of the sensory root of the fifth nerve or removal of a part or of the whole of the ganglion when possible is a justifiable operation. It may lessen the pain and in some cases remove it, but it is not an infallible means of relieving suffering. It is true that as yet no complete removal of a tumor of the Gasserian ganglion is on record, but complete and early removal might be possible. Operation, however has been attempted in very few cases.

Very severe hemorrhage followed the removal by Dr. Frazier of a portion of the ganglion in my Case II, possibly because the tumor may have weakened the walls of the vessels, and rendered them more liable to rupture. This fact should be borne in mind in operations on tumor of the Gasserian ganglion, as after the ganglion is cut

[6] Univ. Penna. Med. Bull., May, 1907, p. 35.

from most of its attachments it is customary to pull it away, and repeatedly a rupture of the cavernous sinus has occurred. It might be well to avoid all pulling on intracranial tissue when operation is performed on tumor of the ganglion, except tearing the sensory root from the pons. This would be the most desirable procedure when the tumor could not be removed.

Hofmeister and Meyer[6] give the literature on tumor of the Gasserian ganglion. It is not very extensive. In their case the tumor was a sarcoma. Marchand[7] has made the pathology of these growths recently a subject of special study. The cases he collected with necropsy are those of Günsburg, Blessig, Petrina and Klebs (two cases), Goodhart, Hansch and Bezold, Krogius, Hegelstam, Prince; Dercum, Keen, and Spiller, and Hofmeister and Meyer. To these Marchand adds another case. It seems remarkable that the cases of tumor of the Gasserian ganglion are not more numerous. I can only believe that these tumors are not diagnosticated in many instances when they exist.

The first operation for tumor of the Gasserian ganglion was done by Krogius.[8] An endothelioma the size of a pigeon's egg was removed, but a portion was left behind. In this case the tumor presented in the nasopharynx. Death occurred from meningitis thirteen days after the operation.

The tumors in my two cases have much the appearance of an endothelioma. As Marchand points out, the newgrowths of the Gasserian ganglion that have been reported seem to have a very similar histology, although different names have been given to them. He is inclined to believe that these tumors arise in the undifferentiated *Anlage* of the ganglion, and that they may be regarded as neurozytomas. In this connection it is interesting to refer to the neuroglioma found in my first case at the junction of the pons with the cerebellum, and distinct from the tumor of the Gasserian ganglion. It may have been a congenital anomaly, and gave little evidence of growth, and was very small. It may afford some support for the opinion that in these cases of tumor of the Gasserian ganglion there is a portion of the *Anlage* of the ganglion which fails to become differentiated into ganglion tissue, and later becomes the seat of a neoplasm. In whatever way these tumors are regarded, the necropsies show that they are malignant, and that they are likely to invade the bone of the skull.

[6] Deut. Zeit. f. Nerven., 1906, xxx, 206.
[7] Festschrift f. von Rindfleisch, 1907, p. 265.
[8] Rev. de chir., 1896, xvi, 434.

THE ETIOLOGICAL IMPORTANCE OF ABNORMAL FOOT POSTURE IN AFFECTIONS OF THE KNEE.[1]

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In all ages builders have realized the importance of a secure foundation, and the "man which built his house upon the sand" has been justly held up to ridicule. In the human frame the foot is essentially the foundation of the body, and mechanical principles are similarly involved, although modified, it is true, by the adaptability of the muscular system. When, however, muscular control weakens, the natural and acquired errors in the structure become apparent and produce symptoms which are easily understood, if viewed in the light of mechanical laws.

Despite the great amount which has been written about the weak foot, few, if any, of the ills to which flesh is heir are more poorly treated; and such will continue to be the case as long as it is deemed sufficient to send the sufferer to the instrument maker for "a pair of plates." To him who aims at the cure of the affection by the restoration of normal function, the available literature furnishes all that is necessary. One of the more remote effects of the weak foot, however, while mentioned by various writers, has not in my opinion received the emphasis which it merits. Through the abnormal position of the foot an excessive strain is thrown upon the knee and its muscles, which may not only give rise to pain in and around the joint, but, if unrelieved, may also produce actual joint changes; further, strain due to such abnormal foot posture may be a very potent factor in keeping up disability of the knee-joint due primarily to other causes.

The references in the literature to this phase of the subject are practically limited to a few works on orthopedic surgery and to several special articles.

In speaking of the more or less unusual symptoms of flat foot, Bradford and Lovett mention the occurrence of pain and a feeling of strain at the insertion of the hamstring tendons, pain and irritability of the knee with, in some cases, recurring attacks of synovitis, and occasionally backache. Whitman states that there may be "pain in the knee, hip, or lumbar region, symptoms more common in women than in men." Dane, in an excellent paper on the mechanics of the subject, definitely locates various points of pain above the ankle, and Stone also refers to them. In an analysis of 1000 cases of static foot trouble, Blodgett noted pain in the knee in 73 cases; in 21 cases the pain was wholly above the ankle, and of

[1] Read at a meeting of the Pittsburgh College of Physicians, February 27, 1908.

these, "13, or more than half, had pain only in the knee, usually over the internal condyle, and 4 others had pain in the knee associated with pain elsewhere above the ankle;" he calls attention to the fact, moreover, that knee symptoms are more common than his analysis would indicate, since cases of villous arthritis, due to flat or pronated feet, were not included in his series. In view of these statements, it is rather surprising to find no mention of pain above the ankle in several of the recent American and German orthopœdic text-books.

As regards the production of definite joint changes, Goldthwait says that chronic villous arthritis of the knee "is very commonly associated with, and is undoubtedly in part due to, flat foot, the weakness here having resulted in strain and weakness at the knee." In the same connection Painter and Erving state: "Flat and pronated feet, by causing strain to the internal lateral ligaments of the knee, are common causes of congested and hyperemic knees, particularly in stout and flabby individuals, usually women."

The value of a corrected foot posture in recurrent dislocation of the internal semilunar cartilage is recognized by Robert Jones and by Lovett, but I have failed to find any reference to its value in other affections.

When studied from the mechanical standpoint, the reasons for the production of symptoms at the knee by a weak foot are clear and distinct. Such symptoms are due indirectly to the inherent instability of the knee and directly to: (1) Strain exerted laterally on the internal lateral ligament, and (2) strain due to interference with the normal rotation of the femur on the tibia; their time of appearance and severity are dependent upon the muscular control.

Inherent Instability of the Knee.—"The knee is a joint depending entirely upon the ligaments for its strength. Disregarding the patella, there are only two small articular areas in contact in all positions of the limb. . . . There is neither cup nor socket nor real concavity of any sort. . . . The two bones with the articular cartilages left on and all the ligaments removed are in unstable equilibrium in all positions. This mechanical disadvantage and the arrangement of the lubricating apparatus, which is at times inadequate and at times an absolute obstacle to the working of the joint, furnish the chief reasons why the knee is the most frequently deranged of all the joints in the human body" (Tenney).

Lateral Strain. There are normally a few degrees of divergence of the thighs, and this is more marked in women than in men on account of the greater width of the pelvis; as Lovett expresses it, "Some degree of knock-knee is anatomic." This necessarily produces a slightly greater strain upon the structures on the inner side of the knee. The assumption of the so-called "attitude of rest," in which the feet are separated and everted, increases this strain in proportion to the degree of pronation (rolling in of the ankle) which

occurs. It is further increased in walking with the legs in outward rotation, since in this position the line of motion of the knee-joints diverges from that of the body. That the force thus exerted upon the internal structures of the knee is one to be reckoned with, is evident, since it is sufficient in susceptible individuals to produce the deformity of knock-knee, to which, in some cases, at least, flat foot stands in causal relation, and the correction of which in the milder degrees is possible by throwing the weight on the outer edge of the foot.

Interference with Normal Rotation of the Femur on the Tibia. The axis of the ankle-joint is directed slightly downward and backward; in the normal foot, according to Dane, the two axes meet in the horizontal plane in an angle open backward of 169 degrees and in the vertical plane in an angle open downward of 154 degrees. This divergence is of undoubted assistance in maintaining the upright position with a minimum of muscular effort. At the knee the final act of extension consists in a gliding backward of the larger, inner condyle, so that the femur is rotated inward on the tibia; similarly, the beginning of flexion is accompanied by a rotation outward of the femur (Quain); this aids in maintaining the knee in extension. Into the mechanism at the hip it is not now necessary to go.

In the assumption of the weak- or flat-footed position, the foot moves inward and downward at the mediotarsal joint, while the heel and the ball remain fixed. This has two effects: (1) The divergence of the axes of the ankle-joints is diminished, and the assistance thereby afforded in the maintenance of the upright position is decreased or lost; and (2) the tibia, which participates in the movement, rotates inward, thus "interfering to a great extent with the operation of the mechanism by which complete extension of the knee should lock the joint and render it proof against the constant tendency of the body weight to flex it" (Dane), thus necessitating the constant exercise of muscular force.

Muscular Support. Normal muscular tone is the prerequisite of a normal posture and a normal gait, and as long as it exists, mechanical defects of a considerable degree may be present without producing symptoms. With diminishing muscular power, the individual tends to assume a posture in which more and more weight is transferred to the ligaments, and under such circumstances slight deviations from the normal become active. Hence it happens that the conditions under discussion are seen in children who have grown rapidly, in the weak and debilitated from any cause, and in the abnormally stout.

As an example of the subject, one may picture the amount of traumatism (to the knees) sustained during the afternoon's shopping expedition of a short, very stout, and correspondingly flabby individual with pronated or flat feet, and wearing the conventional French heel, whose already too small base is more or less

rounded by use; imagine for a moment the repeated injuries that occur from the standing before the counters, the walking over uneven streets, the clambering up and down the very high steps of our streets cars, and possibly the half hour's clinging to the strap while she is jerked this way and that with every movement of the car. With such a complicated joint as the knee the wonder is that any such escape.

Insistance must also be laid upon the fact that in the normal individual a knee which has been injured, either by traumatism or disease, is in exactly the same condition as if the individual were generally weakened. The relaxation of joint structures, which naturally follows inflammation, and the muscular atrophy from disuse render the joint more susceptible to injury. Under such circumstances, in an exactly similar manner, slight deviations from the normal foot posture may throw sufficient strain on the knee to retard or even prevent recovery. In such cases correction of the foot error may bring immediate improvement. It is my opinion that in all cases of primary knee-joint affections any apparent defect of the foot should be corrected, and that in cases of long standing, even in the absence of any apparent defect, the weight should at least be transferred to the outer side and the foot brought into the adducted position. If such details were more carefully carried out in the treatment of acute affections of the knee, it is safe to say that fewer chronic troubles would be seen.

The following cases are presented as examples of this condition; others might be cited, but these are sufficient to illustrate the various types:

Case I.—Mrs. F. G., referred by Dr. James I. Johnston, was seen February 16, 1906. She had first noticed soreness in the right knee about a year and a half before, following extra exertion, and a few weeks after an attack of tonsillitis; two or three weeks later the left knee also became affected. Some puffiness about the joints and "grating" were noted; there was no pain any place else. No benefit had followed a rest in the country nor massage and salt baths at Atlantic City. She now complained of pain up and down the legs, chiefly in front. On account of her circumstances she was obliged to be on her feet a great deal, and was also under considerable nervous strain. The patient was a fleshy, middle-aged women in fair general condition. There was slight fulness on each side of the patella tendons and above the patellæ; no demonstrable fluid; no palpable fringes; slight crepitation; on the right knee there was tenderness over the internal lateral ligament. The feet were markedly everted in walking and there was marked pronation; double hallux valgus of moderate degree was present; the heels of the shoes were small and high.

The knees were supported by flannel bandages, and electricity and compresses were used. The shoes were changed so as to give

a firm base of support and to correct the pronation, and the arches were supported. Improvement was gradual but steady, and when last seen, in May, the patient was quite comfortable.

CASE II.—Mrs. J. D. F., referred by Dr. James P. McKelvy, was first seen June 19, 1907. She had been troubled with stiffness of the knees, especially the left, for two or three years; pain had been absent until the last few weeks, and about a week ago became especially severe in the left knee; the knees were "puffed out on the sides" at night. She had noticed that she was worse when she sat a good deal or ran the machine. The stiffness was the especial complaint.

The results of examination in this case were similar to those in Case I, except that there was considerable swelling (synovial) of the left knee.

Treatment consisted of several weeks' fixation of the left knee in a splint, hot and cold douching, bandaging, etc., and the correction of the foot condition as in Case I. When last seen, in August 1907, the patient was in good condition.

Cases I and II represent the type of congested knees (in some cases going on to villous formation), which are seen in stout, flabby individuals, with flat or pronated feet.

CASE III.—J. S., a male, aged eight years, was referred by Dr. W. W. Jones on account of trouble with the right knee. He was first seen on December 18, 1905. About two years and a half ago, following kneeling on the wet ground, the right knee became swollen and painful, and he was in bed for about two weeks, although not especially inconvenienced. Fifteen months later there was a second attack of pain and swelling, and he was in bed again for a time. Within the last six months he has had trouble three times. His present trouble dates from three weeks ago, when he had a fall, and was supposed by the friends to have put the knee out of joint; several days before coming to see me he had struck it again, and had complained greatly of pain, although he had continued to use it. He had limped slightly for about a week.

The patient was a slender lad in not very good general condition. The right knee was a quarter inch less in circumference than the left (he had been wearing an elastic knee-cap), but the thigh and calf were a half inch larger. There was some spasm of the hamstring tendons. No apparent abnormality of the joint could be detected, except that there was a slight degree of relaxation of the ligaments. The feet were plainly weak, and there was noticable twitching of the muscles during standing; there was in-toe and considerable pronation.

Treatment consisted in support to the knee by a flannel bandage, the alternate hot and cold douche, correction of the abnormal foot posture by changes in the shoe, and later, when the spasm had disappeared, the use of exercises to build up the leg muscles. Up to

February, 1908, when last seen, the patient has experienced no further trouble.

CASE IV.—Miss A. G., aged seventeen years, consulted me May 29, 1906, in regard to pain in the right knee. About four years ago she had twisted the foot and hurt the knee, and since then had "hurt" it at various times, losing a day or two. Pain is referred to the outside of the knee, is dull in character, and lately has run up to the hip; there has also been some pain below the knee; no history of locking or grating; a little swelling has been noted at times.

Here also examination failed to reveal any abnormality in the knee, but the weakness of the feet was at once apparent when the patient walked across the room; the feet were markedly pronated and the toes showed the marks of compression by the improper shoes. Correction of the foot error by a proper shoe, the use of appropriate exercises, and instruction in walking gave immediate improvement, and when seen about a year later, the patient had experienced no further trouble.

CASE V.—S. S., male, aged eighteen years, consulted me October 20, 1907. About a year ago, without any known cause, he noticed swelling of the left knee around the patella, which disappeared under bandaging; there was no redness, no pain, and no interference with motion. He has continued to wear the bandage and the knee seems to be getting weaker. During the last few weeks there has been some pain on the inside of the knee, but no sudden sharp pain, no locking, and no interference with motion. He has noticed at times some stiffness in the arch of the foot, and has a tendency, which he cannot explain, to stand on the outer edge of the foot.

There was marked varicose veins on both legs. The left knee was slightly (not over a quarter inch) larger than the right; the calf was a half inch larger. There were no tender points about the knee and nothing to be felt, except crepitation in the joint. The left foot presented a marked degree of distortion during use, the mediotarsal joint being displaced inward and downward with each step.

The alternate hot and cold douche, a corrective heel, a Whitman arch support, and exercises were prescribed.

When seen ten days later, all discomfort in the knee had disappeared, and when last seen, in December, 1907, there had been no return.

Cases III, IV, and V are of especial interest because of the very early age at which knee symptoms appeared and the very prompt and permanent response to the correction of the static foot error. In these cases the condition was simply one of strain without the production of joint changes.

CASE VI.—R. H. W., referred by Dr. George Wright, was seen March 5, 1907. Five months before he had twisted the right knee through a fall; there was not much swelling or pain and no ecchy-

mosis. A week later, ordinary measures having been used in the meantime, he returned to his home in Boston, where his family physician found effusion into the joint and applied a cast, following which the effusion disappeared in about two weeks; in addition to the fixation he had some massage. When he left Boston he was still limping and motion was limited. After a few months he could walk a mile without discomfort, but more brought on pain just to the inside of the patella, and in the calf and up the leg; there was also some pain in the heel. About two months ago he noticed crepitation. A bone-setter diagnosticated a dislocated tendon and replaced(?) it without apparent effect. He complains most of pain on the inside of the leg near the knee.

The patient was a muscular young adult with noticeable general looseness of the joints. There was considerable atrophy of the leg, but no demonstrable change in the joint; in standing, the right knee was not so fully extended as the left, which, indeed, was slightly recurved; the discomfort of which he complained was located definitely over the inside of the joint. Both feet were markedly pronated and everted, and there was a marked excursion downward and inward at the mediotarsal joint at each step; this postural defect had evidently been present for years.

The knee was treated in a similar manner to that in the previous cases, and the defect of the foot was corrected by changes in the shoe and by a felt pad under the arch. Improvement was soon apparent. Later, when he was going into the woods for a vacation, a steel arch support was made for him, with which he went through an active hunting and fishing trip without discomfort.

After resuming office work, however, there was a slight but persistent return of the discomfort. A course of massage brought up the size of the leg to about that of its fellow, but failed to relieve all the trouble. The patient then volunteered the information that he had less discomfort after walking a long distance than when engaged in less active exercise, as, for example, after billiards. Following out this suggestion, he was allowed to engage actively in walking and other sports, and when last heard of had walked five miles without inconvenience and had been dancing.

Case VI is of interest because of the two points which it illustrates. The static foot error had been present for years without producing symptoms until the resistance of the knee was lowered by injury; then it played a very definite part in preventing full recovery. The general looseness of the joints had also caused no inconvenience, no doubt on account of the excellent muscular development; with the lowering of the muscular tone from disuse, however, this looseness also became an active factor in retarding complete recovery.

Case VII.—T. P. McD., an ironworker, consulted me September 6, 1907. Two months before he had been struck just above

the left patella by a "reverse lever." The knee began to swell in a few hours, but there was no ecchymosis; he was in bed for about a week (but without a splint), and since then has used a cane. He now has most pain in the mornings and gets very tired toward evening; there is some swelling and what he describes as "a catching" below the knee; he complains a great deal of a twitching of the muscles on the front of the thigh; he can walk but a short distance and cannot go up steps.

The patient was a very muscular young adult, in excellent general condition. The left knee was very slightly swollen, chiefly in the region of the infrapetellar pad. The patella floated moderately. The point of tenderness complained of was just above the patella, where he had been struck. There was no apparent abnormality below the knee.

On account of the evidence of fluid in the joint, the knee was first baked and strapped with the adhesive strapping, but, as the strapping produced several large blisters, this was discontinued and the knee put on a splint; massage, electricity, and, later, alternate hot and cold douching were then used. Improvement was not so rapid as was expected, however. After several weeks, although there was no apparent postural defect, the effect of raising the inner edge of the shoe and supporting the arch (by a felt pad) was tried. Both at the time and afterward the patient was very definite in this statement that this "felt better," and improvement was so much more rapid after this that I feel certain it was a valuable adjunct in treatment.

Case VII is important, it seems to me, in suggesting the value of the more general use of temporary support (Thomas heel or felt pad) to the arch in the treatment of injuries of the knee, and since the measure is such a simple one, there is no good reason why it should not be employed.

CONCLUSIONS. 1. The production of symptoms at the knee by abnormal foot posture is easily explained by mechanical laws.

2. Pain in or around the knee may exist unassociated with pain in the foot.

3. Strain at the knee from abnormal foot posture may, if unrelieved, produce actual joint changes.

4. Such strain may also be a potent factor in keeping up disability of the knee-joint due primarily to other causes.

5. In all cases of primary knee-joint disease apparent defects of the foot should be corrected, and in resistant cases, especially old traumatisms, even when no apparent defect is present, the transference of the weight to the outer border of the foot is recommended.

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THE RICIN METHOD OF JACOBY-SOLMS FOR THE QUANTITATIVE ESTIMATION OF PEPSIN.

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(From the private laboratory of Dr. John H. Musser.)

The various methods for the quantitative determination of pepsin in the gastric juice are numerous and ingenious, although but few have survived the test of time and corroboration. The older methods of Brücke, Grützner, Jaworski, Hammerschlag, and Oppler are of interest but of no practical value, while the Mette method has been and is still being so extensively assailed that its position, despite the advocacy of Pawow, seems to be uncertain. The above-named methods have been so frequently described that the omission of their review may be dispensed with.[1]

In 1906, Jacoby,[2] while engaged in a research on ricin, found that a solution of this substance in 1 per cent. sodium chloride solution became cloudy owing to the insoluble albuminous body contained in the substance, but that if pepsin were added to it the solution cleared up rapidly and completely. Jacoby hinted at the clinical application of this observation, but no attention was given the subject until Solms, working under Jacoby, published his paper the following year.

In this article he gives in clear detail the description of his method which he claims is easy, practicable, and inexpensive, and apparently does away with many of the difficulties surrounding the Mette test.

[1] For bibliography see Farr and Goodman, Archives of Internal Medicine, 1908, i, 648.
[2] Arb. a. d. path. Institut. zu Berl., Feier, Johannes Orth, Berlin, 1906, p. 655.

The following description of Solms'[3] technique is copied from the paper of Farr and Goodman. The only materials needed are a solution of ricin and a $\frac{n}{10}$ hydrochloric acid solution.

"The ricin solution is made by dissolving 0.5 gram of ricin in 50 c.c. of 5 per cent. sodium chloride solution and filtering. (The ricin used by Solms was obtained from the Vereinigte chemische Werke, Charlottenburg, Salzufer 16, costing 2 marks for 10 grams. Solms preferred this preparation of ricin to Merck's, principally on account of the limited supply, and the great cost of the latter.) The filtered ricin solution has a somewhat cloudy appearance, but on the addition of 0.5 c.c. of $\frac{n}{10}$ hydrochloric acid becomes decidedly milky. The milky appearance is cleared up by pepsin.

"His technique is as follows: The gastric juice is obtained by extracting the stomach contents one hour after the ingestion of an Ewald-Boas test breakfast. He tests this for the presence of free hydrochloric acid, then determines the total acidity, and in appropriate cases examines for lactic acid. According to his findings he makes varying dilutions of the contents with distilled water. In cases of hyperacidity he dilutes the filtered contents from 1 to 100 to 1 to 10,000, whereas in cases of anacidity or subacidity the dilutions vary from 1 to 10 to 1 to 100. In normal cases he dilutes from 1 to 100 to 1 to 1000.

"In each of five test tubes he puts 2 c.c. of the filtered ricin solution; then with another graduated pipette he adds 0.5 c.c. $\frac{n}{10}$ hydrochloric acid, which causes the mixture to become very cloudy. Having numbered the test tubes, 1, 2, 3, 4, and 5, he puts in the first tube 1 c.c. of boiled gastric juice; in the second, 0.9 c.c.; in the third, 0.8 c.c.; in the fourth, 0.5 c.c.; and in the fifth, 0 c.c. Then he takes the unboiled juice and, having diluted 1 c.c. of juice with 99 c.c. of water, he puts in the first tube 0 c.c.; in the second, 0.1 c.c.; in the third, 0.2 c.c.; in the fourth, 0.5 c.c.; and in the fifth, 1 c.c., so that in each tube there are 3.5 c.c. of fluid. The test tubes are then corked and put in an incubator, where they are allowed to stand for three hours; at the end of this time they are taken out and the tubes examined to see with what dilution the ricin has been cleared up. If an incubator is not at hand, the tubes can be left at room temperature, of course, for a correspondingly longer time.

"In order to obtain a convenient expression of the pepsin contents of a gastric juice, he designates that amount of pepsin contained in 1 c.c. of a 1 to 100 dilution, which is capable of clearing up the ricin solution after three hours' standing in an incubator, as 100 pepsin units. This he has decided on as the normal standard, because after many examinations of specimens of normal acidity he found the ricin to be cleared up by 1 c.c. of a solution diluted 1 to 100."

Solms divided the specimens of gastric juice according to the

[3] Ztschr. f. klin. Med., 1907, lxiv, 159.

acidity as follows: Normal, "almost normal," anacidity or subacidity, and hyperacidity. Under normal acidity are cases showing a positive reaction for free hydrochloric acid with Töpfer's test and Congo paper, and a total acidity of between 40 and 60. "Almost normal" are cases showing a total acidity between 30 and 40, and 60 and 70, with presence of free HCl. Below these values are cases of anacidity or subacidity, and cases showing a total acidity above 70 he calls hyperacidity.

He reports 12 cases of normal acidity, seven of which showed 100, four, 200, and one, 500 pepsin units, and concludes that pepsin units between 100 and 200 may be considered as the normal. Six cases of "almost normal" gastric acidity (between 30 and 40) showed the same thing as did six cases between 60 and 70. In twenty cases of subacidity there was a marked diminution of pepsin units, generally between 10 and 20 units, in some cases below this, so that the amount of pepsin could not be estimated. Thirteen cases of hyperacidity showed a normal pepsin value and in but two cases was the amount of pepsin abnormally high, once 1000 units and in another instance 500 units.

Witte[4] has published a series of 50 patients on which the estimation of pepsin was made by means of ricin and believes the Jacoby-Solms method is exact and simple and is to be strongly recommended. He alters the technique very slightly, suggesting for normal cases a tube containing a dilution of 1 to 50, and in hypoacidity diluting the gastric juice 1 to 1, 1 to 10, 1 to 20, etc. He believes in this way he can detect mimimal amounts of pepsin. Witte has not followed the classification of Solms as to "almost normal" cases, but arranges his series in normal, sub- or anacidity, and hyperacidity. His conclusions are in the main the same as Solms' and he recommends the method very strongly. He queries, however, if there is not a grave source of error, inasmuch as there is no uniform acidity in the test tubes, and he thinks the optimum acidity is disturbed. He suggests for exact scientific work, a neutralization of the acid then by the addition of decinormal hydrochloric acid bringing the acidity to a uniformity. For clinical purposes, however, this not necessary.

Gross[5] objects to the ricin method on one point, and that is that the ricin used by Solms is very impure and there is no way of determining just how much albuminous substance is contained in it. This would seem to be a valid objection, but so far has not been fruitful of error as Solms, Witte, and I have obtained similar results, each working with separate specimens of ricin.

Solms is particularly insistent that studies with his method be carried out according to his description, in order that comparative studies may be obtained, which may be of value in diagnosis and therapeusis of gastric diseases. In our series of cases we have

[4] Berl. klin. Woch., 1907, p. 1338. [5] Ibid., 1908, p. 643.

followed to the minutest detail Solms' directions, and while not varying from it have chosen in many cases to report the total acidity, free acid, combined acidity, and the acid salts. Control of Solms' method by means of the Mette test was made in ceratin cases by Dr. Farr and reported by us in connection with another phase of pepsin determination.[6] The arrangement of our tables differs slightly from that of Solms inasmuch as we do not favor "almost normal." This seems to be an injudicious subdivision, and we prefer to call gastric juice with total acidity between 40 and 60 normal, and below or above the subacidity or hyperacidity respectively.

TABLE I.—NORMAL ACIDITY (40–60).

Serial number.	Total acidity.	Free HCl.	Combined HCl.	Acid salts.	Rennin.	Ricin.	Mette.	Diagnosis.	Case number.
1	40	30	5	5	+	100–200	3.8 (14.4)	Hyperchlorhydria.	464
2	44	26	2	16	+	200	3.2 (10.2)	Gastro-enteroptosis.	505
3	45	20	20	5	+	100	Not made.	Gastric neurosis.	663
4	48	10	26	12	+	100	4.9 (24.0)	Chloro-anemia.	311
5	50	18	14	18	+	10	3.9 (15.2)	Chronic gastritis.	570
6	50	30	15	5	+	200	4.4 (19.4)	Migraine; dilatation of stomach.	511
7	54	34	18	12	+	100–200	4.3 (18.5)	Gastric neurosis.	434
8	54	36	8	10	+	100	Not made.	Tuberculous enteritis.	659
9	56	24	18	14	+	100	Not made.	Cholecystitis.	884
10	58	30	16	12	+	100 not clear	3.7 (13.7)	Hyperchlorhydria.	402
11	58	34	16	8	+	100	3.0 (9.0)	Neurasthenia; gastric neurosis.	449
12	60	45	5	10	+	100	5.2 (27.0)	Cholecystitis; hyperchlorhydria.	791

Normal acidity (40 to 60). In these cases we have found the pepsin unit to be between 100 and 200 and agree with Solms in regarding this as the normal. Using the Mette test as a control we have found a certain parallel between the two, both giving normal values, although the ricin method does not show the finer variation disclosed by the Mette method (Table I).

TABLE II—SUBNORMAL ACIDITY (BELOW 40).

Serial number.	Total acidity.	Free HCl.	Combined HCl.	Acid salts.	Rennin.	Ricin.	Mette.	Diagnosis.	Case number.
1	35	0	15	20	0	10–20	2.3 (5.3)	Endarteritis; chronic tuberculosis.	140
2	28	6	14	8	Slow.	10	2.8 (7.8)	Cholelithiasis; gastritis.	251
3	26	0	..	..	..	20–50	2.0 (4.0)	Polycythemia; chr. gastritis (vomitus).	814
4	26	8	6	12	Slow.	10–20	3.3 (10.9)	Gastric neurosis.	579
5	25	0	0	0	Very slow.	10	0.8 (0.64)	Pyelitis.	189
6	22	0	..	..	..	10	1.0 (1.0)	Lactic acid +; chronic gastro-enteritis.	813
7	22	0	0	0	+	0	3.4 (11.6)	Chronic gastritis.	571
8	20	0	0	0	0	0	0.1 (0.1)	Anacidity.	576

[6] Loc. cit.

TABLE III—HYPERACIDITY (ABOVE 60).

Serial number.	Total acidity.	Free HCl.	Combined HCl.	Acid salts.	Rennin.	Ricin.	Mette.	Diagnosis.	Case number.
1	62	30	22	8	+	100–200	Not made.	Goitre; dilated stomach.	871
2	62	34	6	22	+	100	2.8 (7.8)	Psoriasis; eczema.	520
3	62	36	20	6	+	100–200	4.1 (16.8)	Gastric neurosis.	300
4	62	16	40	6	+	10	3.8 (14.4)	(Vomitus); carcinoma pylorus.	227
5	64	40	20	4	+	100	3.3 (10.9)	Neurosis.	575
6	64	30	24	10	+	100	Not made.	Nephritis; gastritis.	824
7	64	48	10	6	+	100	3.1 (9.6)	Adhesions; hyperchlorhydria.	615
8	65	40	5	20	+	100–200	3.6 (13.0)	Glycosuria.	500
9	65	40	15	10	+	100	3.4 (11.6)	Syphilis; neurasthenia.	176
10	66	40	11	15	+	100	2.8 (7.8)	Myalgia.	680
11	66	36	22	8	+	100	3.2 (10.2)	Tachycardia.	236
12	66	40	20	6	+	100	Not made.	Gastroptosis; gastric neurosis.	225
13	68	24	29	15	+	200	3.6 (13.0)	Frontal sinusitis; neurosis; hyperchlorhydria.	423
14	68	42	20	6	+	200	4.3 (18.5)	Gout; neurosis; alcoholic gastritis.	498
15	68	34	26	8	+	100 not clear.	3.3 (10.9)	Pancreatitis; hyperchlorhydria.	356
16	68	46	16	6	+	100–200	4.6 (21.2)	Cholecystitis; gastric ulcer.	322
17	68	44	6	18	+	100–200	5.9 (34.8)	Chronic appendicitis; gastric neurosis.	757
18	70	40	25	5	+	100	Not made.	Jaundice; cholecystitis.	664
19	70	40	15	15	+	100–200	4.0 (16.0)	Gastritis; hyperchlorhydria.	734
20	70	54	15	1	+	1000	5.8 (33.6)	Hour-glass contraction of stomach; pyloric adhesions.	282
21	70	46	12	12	+	100	3.2 (10.2)	Fibroid of uterus; hyperchlorhydria.	371
22	74	44	22	8	+	100	4.7 (22.0)	Hyperchlorhydria; pylorospasm; cholecystitis; chronic appendicitis.	335
23	75	55	15	5	+	100	3.0 (9.0)	Hyperchlorhydria.	538
24	75	40	10	25	+	100–200	3.0 (9.0)	Exophthalmic goitre.	455
25	76	30	32	14	+	100	4.0 (16.0)	Appendicitis.	326
26	78	56	20	2	+	100	3.5 (12.3)	Chronic appendicitis.	593
27	78	64	2	12	+	1000	3.8 (14.4)	Appendicitis; hyperchlorhydria.	476
28	78	36	26	16	+	100	3.9 (15.2)	Hyperchlorhydria.	450
29	78	40	16	22	+	100	3.8 (14.4)	Gastric ulcer.	430
30	80	55	15	10	+	100	3.4 (11.6)	Hyperchlorhydria.	678
31	80	55	20	5	+	100	3.0 (9.0)	Hyperchlorhydria.	585
32	82	52	18	12	+	100	3.0 (9.0)	Hyperchlorhydria.	T.T.M.
33	82	52	14	16	+	100	3.8 (14.4)	Bronchitis; gastritis.	599
34	82	54	24	4	+	100	3.4 (11.6)	Gastritis.	689
35	84	52	28	4	+	100	3.1 (9.6)	Hyperchlorhydria.	T.M.B.
36	84	60	20	4	+	100	Not made.	Neurosis; hyperchlorhydria.	883
37	85	35	35	15	+	100	2.9 (8.4)	Neurasthenia; gastroptosis.	692
38	85	55	25	5	+	100	2.6 (6.8)	Gastric neurosis.	667
39	86	48	28	10	+	100	4.9 (24.0)	Gastric neurosis.	561
40	86	58	2	26	+	100	5.2 (27.0)	Appendicitis: hyperchlorhydria.	273
41	88	54	22	12	+	500	2.8 (7.8)	Cholecystitis; hyperchlorhydria.	171
42	88	58	24	6	+	100–200	4.9 (24.0)	Frontal and ethmoidal sinusitis; hyperacidity.	785
43	88	62	12	14	+	1000	5.3 (28.0)	Gastritis; hyperchlorhydria.	334
44	95	60	25	10	+	500	3.1 (9.6)	Neurosis; hyperchlorhydria.	489
45	100	45	20	35	+	100	2.9 (8.4)	Gastric ulcer.	597
46	106	94	10	2	+	100–200	Not made.	Cystitis; enteritis.	828
47	110	62	32	16	+	200	3.7 (13.7)	Epilepsy (?).	713

Subnormal acidity, below 40. Here again we agree with Solms, as there was a marked reduction of pepsin units co-relative with diminished acidity. The Mette method also gave low pepsin value with the exception of two cases, Nos. 4 and 7, in which the amount was normal. This discrepancy between the two methods is more apparent than real, however, as the control tests used for the Mette estimations were also high (Table II).

Hyperacidity above 60. In 5 cases Nos. 20, 27, 41, 43, and 44 the pepsin value was high. That this sometimes occurs has been pointed out by Solms, but in the majority of cases our results showed normal pepsin units. The Mette test in Cases 20 and 43 was also high, whereas in Case 27 it showed a normal value. In Cases 41 and 44 the Mette was low, which is explained by the low result obtained in the control experiment (Table III).

We have thus been able to study the estimation of pepsin by the Jacoby-Solms method in a large series of cases, and we can corroborate Solms' findings. The method is extremely simple, cheap, and sufficiently accurate for all clinical purposes. The rapidity with which one obtains a result is not the least important factor in advocating its use by clinicians. That it does not possess the finer variations of the Mette method cannot be denied, but in the present state of our knowledge of pepsin this cannot be offered as an objection, as this so-called advantage has been of no help to us in diagnosis.

Experiments were made in a limited number of cases to determine if a uniform acidity made any difference in the final result, and whether the law of Schültz held good for the ricin method. So far both of these questions must be answered negatively.

Conclusions: (1) The normal pepsin unit as disclosed by the ricin method is between 100 and 200. (2) Cases of hyperacidity with few exceptions are not accompanied by a corresponding increase of pepsin. (3) Cases of subacidity are invariably associated with a diminution of pepsin. (4) The ricin method is to be recommended on account of its simplicity, cheapness, accuracy, and rapidity.

REVIEWS.

ANATOMY, DESCRIPTIVE AND SURGICAL. By HENRY GRAY, F.R.S., Fellow of the Royal College of Surgeons; Lecturer on Anatomy at St. George's Hospital Medical School, London. Seventeenth Edition, thoroughly revised and re-edited, with additions, by JOHN CHALMERS DACOSTA, M.D., Professor of the Principles of Surgery and of Clinical Surgery in the Jefferson Medical College, Philadelphia; and EDWARD ANTHONY SPITZKA, M.D., Professor of General Anatomy in the Jefferson Medical College, Philadelphia, Pp. 1614; 1149 Engravings. Philadelphia and New York: Lea & Febiger, 1908.

THE semicentennial edition of any scientific work is worthy of comment for more reasons than one. As a general rule, books which belong to the "literature of knowledge" die with their authors, and in many cases are out of date even before that time; the perennial publication of new editions of works of the so-called "literature of power" calls for no special comment, for such classics never become superannuated. It must be, then, that *Gray's Anatomy* possesses certain peculiar characteristics which have not only caused it to survive its lamented author by nearly fifty years, but which have also made it almost impossible for its many rivals successfully to supplant it in the affections of teachers and students.

Comparing the first edition with the last, and with the fifteen intervening issues, one is struck forcibly by two things—first, that few of the original illustrations have been displaced; and, second, that the descriptive text has required scarcely any change other than amplification. Gray wrote his *Anatomy* in order to teach the subject to students; he set down in clear but graceful language the essential facts as they were then known; and he arranged his matter so skilfully as to render the appreciation of these facts easier when studied from his volume than from others then in existence. The facts themselves were not new, and equally accurate descriptions of the various parts of the human frame could be found in Sharpey, in Quain, and in other then popular text-books; but Gray's presentation of these old facts was new, and his illustrations were so far in advance of those in other works as at once to captivate the student's eye.

The previous American edition, also edited by DaCosta, was so favorably reviewed in these columns, and is so well known to the readers of these pages, that an extensive analysis of the present edition is not necessary. This new edition is more than twice the size of the original of 1858, and the number of the illustrations has been increased from 719 to 1149, mostly by the addition of figures from Spalteholz, Testut, Poirier and Charpy, and other European writers; but it is a notable commentary on the art of modern illustration to add that Gray's original woodcuts are still unsurpassed. The initial sections on general anatomy and on development have been omitted, as in the last edition; and the space thus gained has been used to expand and add to the paragraphs devoted to descriptive and surgical anatomy. In the new edition the surgical anatomy of the following subjects has been more fully developed: mastoid disease, the axilla, the cervical fascia, the prostate, the lymphatics and veins, and the abdominal organs.

The arrangement of the subject matter remains much as it was, with the exception of the chapter dealing with the central nervous system, which has been rewritten by Spitzka, about 100 pages being added to the matter contained in Pick's edition. It was probably necessary that this section should be rewritten, as so much new matter had to be added and so many new terms had to be introduced. It is, however, a matter of regret that the advance of knowledge and the changes in terminology render some paragraphs nearly unintelligible to graduates of more than a very few years' standing. We venture to assert, for instance, that none save neurologists or professed anatomists will appreciate at its true value the following description of the choroid fissure: "The rima is nevertheless a gap between the diencephalic part and the overlapping and recurved telencephalon produced by the extension of the secondary forebrain vesicle in an arcuate manner, which Hill described by the phrase 'rotation of the great forebrain.' It is along this arcuate and fissure-like gap that the richly vascular (pial) paraplexus invaginates the atrophied parietes of the secondary forebrain to form the paraplexus which is everywhere covered by endyma. The rima extends from the porta to near the tip of the medicornu in an arcuate course and endymal reflections everywhere close in this gap except at the porta." Fortunately there are occasional oases in this desert of words in the nature of illustrations, which enable the student to see at a glance what it takes so long to describe. A number of the illustrations are from Dr. Spitzka's own pen; several of them show the deeper parts of the brain *in situ* as if seen through transparent overlying structures. "Special effort has been bestowed on combining the features visible to the naked eye with those seen only under high magnifying powers. By the knowledge of macroscopic and microscopic structures the attentive student is enabled to resolve or reconstruct, in the three dimensions of space, and see

with his mental eye the opaque interior resolved into intricate yet well-defined projecting and associating mechanisms."

Apart from the nervous system, the sections in which the greatest changes will be noted are those dealing with the lymphatics and veins. These are thoroughly abreast of the times; and numerous excellent illustrations have been added. In the edition of 1896 the lymphatics were discussed in thirteen pages, whereas in the present volume forty-two pages are devoted to the subject; while the section dealing with the veins has been expanded from thirty to more than fifty pages.

Some confusion seems to exist as to the relation of Colles' fascia to the base of the triangular ligament; in the text (p. 461) it is distinctly stated that the two layers of the triangular ligament are united to each other posteriorly, and that the superficial layer is continuous with Colles' fascia; yet illustrations from Denonvilliers, from Testut, from Henle, and from Poirier and Charpy (Figs. 308, 1062, 1052, 1048) are inserted which show the triangular ligament open posteriorly, and fibromuscular bands (the so-called recto-urethralis muscle) passing from the deep transversus perinei back to be inserted into the rectum; and the recto-urethralis muscle is spoken of in the text as equivalent to certain fibers of the pubococcygeus muscle (the *levator prostatæ* of Santorini). It has been our own impression, from experience in the dissecting room, that the illustrations quoted are correct, and that the text is inaccurate, although the former editions of *Gray* described the triangular ligament in the same way.

The make-up of the volume is improved by the more generous use of heavy-faced type of various fonts, and by printing the origin and insertion of muscles in italics. The new international nomenclature has been introduced in parentheses after the classical names of the various structures. We regret to observe that the original dedication to Brodie, which disappeared first in the edition of 1905, is still missing.

It is safe to predict, on account of the familiarity of the profession with previous editions, that this new edition of *Gray* will continue to be welcomed as a household friend, and that teachers of anatomy all over the country will take an early opportunity to invite prospective members of the profession to join in the celebration of the golden wedding anniversary of *Gray's Anatomy* and students of medicine.

A. P. C. A.

AMERICAN PRACTICE OF SURGERY. Edited by JOSEPH D. BRYANT, M.D., LL.D., and ALBERT H. BUCK, M.D., of New York City. In eight volumes. Vol. IV; pp. 1010; 736 illustrations. New York: William Wood & Co., 1907.

THE successive volumes of the American Practice of Surgery continue to appear with commendable promptness. Volume IV concludes Part XIII, with a chapter on dislocations, by Emmet Rixford, M.D., of San Francisco. Part XIV comprises so-called operative surgery, embracing general considerations and the contra-indications to operating, by Charles B. G. de Nancrède, M.D.; preparations for an operation, by George Ben Johnston, M.D.; anesthetics and the production of general anestheia, by Freeman Allen, M.D., and Frederick E. Garland, M.D., both of Boston; the production of local anesthesia for surgical purposes, by James F. Mitchell, M.D., of Washington, D. C.; amputations and disarticulations, by William Louis Rodman, M.D., LL.D., and John Stewart Rodman, M.D., of Philadelphia; excisions, by Horace J. Whitacre, M.D., of Cincinnati; ligature of arteries and veins in their continuity, by John M. Keyes, M.D., of New York City; minor surgery, by Russell S. Fowler, M.D., of Brooklyn; plastic surgery, by James S. Stone, M.D., of Boston; while the volume closes with Part XV, orthopedic surgery, including articles on congenital dislocations, and infantile paralysis, both by Charles F. Painter, M.D., of Boston; torticollis, by George D. Stewart, M.D., of New York City; deformities and disabilities of the lower extremities, by Royal Whitman, M.D.; and tuberculous disease of the spinal column, by Clarence L. Starr, M.B., M.D., of Toronto.

Dr. Rixford covers the subject of dislocations in a fairly satisfactory manner, especially interesting being his descriptions of the mechanism by which the various luxations are produced. Probably no two surgeons will ever be in entire accord on this perplexing topic; but we had thought the idea that the humerus is dislocated "in a considerable proportion of cases," by blows on the point of the shoulder, had long since been abandoned; nor can we be persuaded that the theory of "transmitted thrust" will satisfactorily account for dislocation of either end of the clavicle. It seems much more reasonable to invoke here, as at the elbow and the hip, the theory of leverage. In speaking of "Kocher's method" of reducing luxations of the shoulder, Rixford states that it is a modification of Schinzinger's; but he fails to credit Henry H. Smith, formerly professor of surgery in the University of Pennsylvania, with being the first to systematize the reduction of shoulder dislocations by manipulation, and teaching to his students a method closely resembling Kocher's long before the name of Kocher was known in surgery. It is worthy of note, perhaps, that among 28 cases treated by Kocher himself by his own method of manipulative reduction, he produced

three fractures of the humerus. It is a pleasure, on the other hand, to see the credit given Allis for his monumental work in connection with dislocations of the hip. In attempting to explain the classification and nomenclature of dislocations of the ankle, we cannot but think that Dr. Rixford resembles that ancient personage referred to in the Bible as darkening counsel by words without knowledge.

In discussing the preparations for an operation, Dr. Johnston seems a little too prone to think only of abdominal surgery. He advises the routine administration of morphine $\frac{1}{6}$ to $\frac{1}{4}$ grain, with atropine $\frac{1}{100}$ to $\frac{1}{150}$ grain before operation. That the combined cap, face-mask, and hood, for operating, covering everything from the vertex to below the shoulders, is especially valuable in hot weather, is a dictum to which many surgeons will not accede. Dr. Johnston considers that "all disinfectants, except soap, are unnecessary." This is one among several quasi-epigrammatic statements made in the article which seem injudicious, even if literally true.

Under local anesthesia, Mitchell discusses also spinal anesthesia. The latter he prefers to strictly local anesthesia only in rectal and prostatic work.

Amputations and disarticulations are described in a rather perfunctory manner, and there is occasionally a little carelessness of expression which is distressing. There is no mention of the proper relation of flaps formed by transfixion to the vascular supply of the limb; and were surgeons to follow the directions given there would be great danger of the point of the knife slitting up the femoral artery in Hunter's canal, or the brachial in the middle of the arm. Moreover, we fail to see why grasping the amputating knife between the thumb and forefinger of the right hand is especially important if the operator stands to the left of the patient (p. 275)—unless, perchance, the authors aim to inculcate ambidexterity, and prefer to use the "thumb and forefinger" of the left hand when standing on the patient's right. At best, it must be admitted that a somewhat insecure grasp is afforded by the "thumb and forefinger" of either hand. The long anatomical descriptions might well have been omitted. Twenty-three pages (out of a total of 104) are devoted to amputations of the foot. The space gained by curtailing these sections could have been devoted with profit, we believe, to the indications for the special methods of amputation, a subject which is too little appreciated by the average surgeon, and one which Dr. Rodman from his wide experience, should be well fitted to teach. A few paragraphs on the adaptation of artificial limbs have been added, but in a work which aims to be abreast of the times it is strange that the work of Vanghetti and of Ceci in performing amputations suitable for cinematic prosthesis is not even mentioned. Original illustrations are conspicuous by their scarcity.

There is nothing particularly noteworthy in Dr. Whitacre's

account of excisions. He states that there is a tendency for surgeons to be more radical in their operations for tuberculous bone disease; this statement scarcely seems to be warranted at a time when hygienic surroundings and open-air treatment of such patients are surely steadily decreasing the number of operations required. He flatly contradicts himself (pp. 427 to 434) as to the indications for excision of the hip in ankylosis. He waxes quite enthusiastic over formal excisions of the wrist and ankle, operations on which most surgeons of experience have placed a ban.

One might expect to find in the article on ligature of arteries and veins some reference to arteriorrhaphy; but even the suture of veins is not mentioned. It is to be hoped that these topics of actual interest will find a place somewhere among the eight volumes.

Plastic surgery is treated in a lengthy and cyclopedic monograph by Stone. Following an excellent account of the principles of plastic surgery, the various special procedures are described, and amply illustrated. He is very cautious in his recommendation of paraffin prosthesis, dwelling upon the immediate dangers and the remote failures.

Painter contributes a pessimistic article on congenital dislocations. He accepts fœtal malformation as the cause. He thinks true congenital luxation of the shoulder very rare, believing this deformity when found in infancy to be usually due to obstetrical or infantile palsy. He classes Madelung's disease with congenital dislocation of the wrist, believing it to be acquired before birth, but that its manifestations are delayed until the age of puberty. In the account of the history of congenital luxation of the hip, the name of Paci is not even mentioned, although Hoffa and Lorenz are given prominent places. He states that all cases cannot be treated successfully by identical means, an important truth which is sometimes forgotten; and before deciding on the method of treatment, he thinks the surgeon should determine the anatomical condition of the head and acetabulum, and the relation of the former to the shaft. He states that when reduction has been accomplished the occurrence of reluxation during application of the cast ought not to be easy if permanent success is to be attained. He uses the Bartlett or Bradford machine for reduction; he regards the production of hematomas and tears of the skin as "not often of serious consequence," acknowledges to having himself fractured both pubic rami by the machine, and speaks lightly of other accidents, the most serious being rupture of vessels, fracture of the femur and pelvis, and occasional injury of the great trunks. Surely those who wish surgery to be a gentle art will have their hair made "to stand on end like quills upon the fretful porcuptine" when they read these paragraphs.

In reviewing the third volume of the *American Practice of Surgery*, we noted with regret that the subject of Pott's disease of the spine had not been assigned to Prof. Primrose; but we count the sub-

scribers to these volumes fortunate in that it is treated in the present volume by a colleague of Primrose. Dr. Starr presents his readers with a most admirable article—indeed, the best in the volume—which sets forth in a lucid and scholarly manner the pathology, symptomatology, and treatment of this serious disease and its complications. Among the latter is abscess, which is considered responsible for the great bulk of deaths, either from prolonged suppuration, or from the development of tuberculous meningitis. Infection with organisms other than the tubercle bacillus, he holds, may arise in three ways: (1) Usually from the sinus through which the abscess discharges; (2) not infrequently from the deeper layers of the skin (sweat and sebaceous glands) as the abscess approaches the surface; and (3) through the blood current. The great problem, therefore, is to prevent the discharge of the abscess or its infection by "pyogenic" organisms. He quotes Calot's aphorism that the spontaneous opening of an abscess is "an open door through which death very quickly enters." He advocates, therefore, early free incision of the cold abscess, as soon as it approaches near enough to the surface to be accessible, but before the skin itself has been invaded by tuberculous disease. This is followed by thorough evacuation of its contents, wiping its walls dry with iodoform gauze, and suturing the incision tight by deep sutures. Among 60 cases which he has treated in this manner, 51 have remained perfectly closed for periods varying from six months to five years. When this is compared with Primrose's experience, narrated in Vol. III, we think the value of this method over that of repeated (and usually unsuccessful) aspiration and injection, or waiting for the spontaneous evacuation of the abscess, has been sufficiently demonstrated. A. P. C. A.

Diseases of the Genito-urinary Organs and the Kidneys. By Robert Holmes Greene, A.M., M.D., Professor of Genito-urinary Surgery in the Fordham University, New York, and Harlow Brooks, M.D., Assistant Professor of Pathology in the University and Bellevue Hospital Medical School, New York. Pp. 536; 292 illustrations. Philadelphia and London: W. B. Saunders Co., 1907.

This book is a conjoint product of a surgeon and a physician, and the subjects are considered from the standpoint of the general practitioner and the surgeon. After carefully perusing the work, we believe that it will be of more value to the former than to the latter.

It presents all the latest improvements in the diagnosis of the diseases of the genito-urinary tract. The chapter on cystoscopy

shows well the knowledge that can be obtained of vesicorenal conditions by this instrument in experienced hands. The directions for its use are given in detail. The medical aspects of Bright's disease, together with the application of surgery to the treatment of this condition, are set forth in full. The chapter on tuberculosis of the kidney presents many admirable points, but is open to some criticism. In the first place, insufficient stress is laid on hematuria, and how it can be differentiated from the hematuria occurring in other conditions. No mention is made of the danger of infecting the normal kidney by catheterization of the ureters when the bladder itself is a seat of a tuberculous lesion. No mention is made under the head of kidney or bladder tuberculosis of the good results obtained by early nephrectomy.

As has been indicated before, the portions of the book dealing with operative technique are most open to criticism. For instance, in operating for calculus, needling of the kidney is recommended for localizing the calculus. Any surgeon with experience knows how unreliable this measure is.

Considerable attention is given to the subject of floating kidney, but not sufficient to the mechanical support of such a kidney by a properly fitting corset. In the diagnosis of this condition the passage of metal ureteral catheters, which may indicate the position of the kidney in an *x*-ray plate, is recommended. Such a diagnostic measure in the hands of any but the most experienced must be a dangerous procedure in the presence of a diseased or kinked ureter. In describing the operations for fixation of the kidney, no mention is made of that operation which was first suggested by Harris, of Chicago, which has for its object the obliteration of the peritoneal pouch, into which the kidney falls. Again, illustrating the deficiency of the work as a guide for the operative surgeon, we quote the following paragraph, which is all that is given on the operation of ureterotomy for stone, excepting a brief mention of the extraperitoneal operation: "For removing a stone from the ureter, the longitudinal incision is the preferable one. Occasionally, operating through the bladder, a stone may be removed from the ureter by the finger or by the use of long narrow forceps if the mouth is, as occasionally happens, dilated." It will be observed that no mention is made of suturing the ureter, or whether or not drainage is indicated, two important points in the operative technique.

The chapter on stone in the bladder is good, and the closing portions of the book, which deal with lesions and deformities of the external genitalia, are up-to-date and authoritative. J. H. G.

THE BACTERIOLOGY OF DIPHTHERIA, INCLUDING SECTIONS ON THE HISTORY, EPIDEMIOLOGY, AND PATHOLOGY OF THE DISEASE, THE MORTALITY CAUSED BY IT, THE TOXINS AND ANTITOXINS, AND THE SERUM DISEASE. By F. LOEFFLER, M.D., LL.D.; AURTHUR NEWSHOLME, M.D., F.R.C.P.; F. B. MALLORY, M.A., M.D.; WILLIAM H. PARK, M.D., AND CHARLES F. BOLDUAN, M.D. Edited by G. H. F. NUTTALL, M.D., PH.D.,Sc.D., F.R.S., Quick Professor of Biology in the University of Cambridge, Fellow of Christ's College; and C. S. GRAHM-SMITH, M.A., M.D., University-Lecturer in Hygiene, Cambridge. Cambridge at the University Press, 1908.

THIS book is truly a monumental work upon the bacteriology of diphtheria. From every point of view the subject is discussed exhaustively. In such extensive treatises, in which the various sections are written by different persons, it not infrequently happens that there is a good deal of repetition, but owing to the excellence of the editing of this book such an error has fortunately been avoided. The book opens with an introductory chapter on the history of diphtheria, contributed very appropriately by Loeffler; an interesting section then follows by Newsholme on the epidemiology. Mallory contributes a splendid section upon the pathology of diphtheria, fully illustrated by reproductions of photo-micrographs. The text is based principally upon the study of 251 cases of diphtheria which came to autopsy at the Boston City Hospital. The section upon diphtheria bacilli and diphtheria-like bacilli, containing several chapters and covering over 300 pages, is written by Grahm-Smith. The subject is considered in the greatest detail and the various chapters contain practically everything that is known about this group of organisms. In regard to the relationship between the true diphtheria bacillus and the pseudo-diphtheria bacillus, or Bacillus Hofmannü as Grahm-Smith terms it, he states that there is no evidence to show that the one is an attenuated and non-pathogenic form of the other; he thinks, rather, that the recent investigations go to show that the two organisms belong to different species. In one chapter he has collected interesting statistics bearing upon the presence of virulent and non-virulent diphtheria bacilli in the throats of healthy persons. From the study of between 2000 and 3000 reported cases he finds that virulent diphtheria bacilli are found in the throats of 0.1 to 0.2 per cent. of healthy persons, whereas non-virulent bacilli are found in from 1 to 2 per cent. On the other hand, a large proportion of persons who actually come in contact with cases of diphtheria, harbor virulent bacilli in their mouths, 8.7 to 66 per cent. In the chapter upon modes of infection he points out the possibility, though slight, of milk epidemics. One chapter in the section by Dean on the types

of immunity and the toxin of the diphtheria bacillus, is devoted to a discussion on the effects of antitoxin on toxin, and is given over in large part to a criticism of the views of Arrhenius and Madsen. The book closes with two chapters by Park and Bolduan, one on the mortality of diphtheria, and the other on the serum sickness. The book which numbers 700 pages is probably the most complete treatise upon the bacteriology of diphtheria that has ever been written, and as a book of reference is invaluable. The bibliography at the end of the volume covers over 60 pages.

W. T. L.

CLIMATE, CONSIDERED ESPECIALLY IN RELATION TO MAN. By ROBERT DECOURCEY WARD, Assistant Professor of Climatology in Harvard University. Pp. 374 illustrations. New York: G. P. Putnam's Sons; London: John Murray, 1908.

IN spite of the author's reassurance that *Climate* is intended to be "a book which can be read by any intelligent person who has not had special or extended training in the technicalities of the science," the first part of the book is nevertheless somewhat difficult for the uninitiated to follow. The first impression produced is that a very large amount of material has been compressed into a very small compass, and to the lay reader it seems that many things are either left to his imagination or taken for granted as matters of common knowledge. The book could be greatly expanded without adding any new material, and the numerous examples taken from almost every branch of knowledge call for more liberal treatment.

Passing over the initial chapters devoted to technical matters, such as nomenclature, classification, and the like, we come to a wealth of interesting statistical information in the chapters on the characteristics of the zones, dealing with such questions as the physiological effects of heat and humidity, the effects of season and weather on man, and marine and mountain climates. The effects of climate on man, his customs, manners, pursuits, and lines of development, are interestingly set forth in separate chapters under the three general subdivisions of tropical, temperate, and polar zones. The author points out, however, that other factors must be considered in explaining many of the phenomena that have been rashly attributed to the influence of climate alone; such as the color of man's skin, which is believed to become paler with increasing distance from the equator; the overhanging eyebrows and partly closed eyes of the negro; the small stature of the African pygmies, which has been attributed to the heavy equatorial rains. Migration from place to place, with the accompanying change in man's food, habits, and pursuits; heredity; intermarriage; the character of the soil and

the different opportunities it creates, and, finally, the element of time are some of the factors that, no less than climate in the narrower sense, contribute to the final result whatever it may be.

In the chapter on the hygiene of the zones the author adopts, to a certain extent, the medical standpoint and in his medical facts he is quite accurate. The important part played by microörganisms in the production of disease is fully appreciated. The beneficial effects of different climates and the reasons therefore are interestingly discussed—the stimulating effect on the breathing apparatus of the rarefied air of high altitudes; the purity and freedom from germs of desert air, without the stimulating qualities of mountain climates, which are sometimes undesirable; the beneficial effects of forested areas in pulmonary tuberculosis; the purity, freedom from dust, and equability of temperature of ocean air so beneficial during convalescence; the ventilating and putrifying action of the winds in congested districts; the germicidal action of sunlight and the interference with this action by fogs and clouds. The geographical distribution of diseases is, however, by no means definite, being subject to many exceptions and variations. Seasonal differences are often due to some secondary factor, such as overcrowding under unhygienic conditions during the winter season. We commend particularly the paragraphs devoted to individual diseases and their distribution. Much light has been shed on this interesting subject by recent discoveries, notably in regard to tropical diseases. It is pointed out that it is not so much the climate that produces or favors a certain disease, as the fact that conditions in certain localities are favorable to the life of the cause of the disease, as in the case of malaria and yellow fever and all diseases dependent directly or indirectly on animal life. R. W. G.

Outlines of Psychiatry. By Wm. A. White, M.D. New York: The Journal of Nervous and Mental Disease Publishing Co., 1907.

This small volume of two hundred and thirty pages, by the superintendent of the Government Hospital for the Insane, Washington, D. C., is the first of a series of monographs on nervous and mental diseases. The editors, Drs. Jelliffe and White, announce that the series will consist of short monographs, translations, and minor text-books on subjects related to nervous and mental diseases. The publication of this work will, therefore, establish a new departure in the literature of nervous diseases and psychiatry, and it is to be hoped will lead to a more systematized presentation of investigating work in this field. The need for the opportunity of

presentation of work in such a form has long been felt, and, with proper care and selection of the work presented there need be no question as to the success of the project.

Dr. White's work on psychiatry is a systematic presentation of mental diseases. The first half of the book is devoted to general considerations, with a very full and important chapter on the examination of the insane (in the preface the author expresses his indebtedness for this chapter to Dr. Shepherd Ivory Franz). This portion of the work is presented with a thoroughness and scientific insight that is somewhat lacking in the detailed presentation of the individual psychoses in the second half of the volume. This, however, is evidently not a matter of ability on the part of the author, but is evidently due to the lack of space for the presentation of his subject. It is simply impossible to present in one hundred and twenty pages a description of the various types of mental disease in such a way that each will stand out as a clear-cut picture in the mind of the student or practitioner who has only an occasional opportunity to see mental disease. It will, on the other hand, suffice for an outline for those who have an opportunity of studying large numbers of cases. For those, indeed, it will have a special value, in teaching them the use of the technical language so necessary to describe mental states. That this was evidently the purpose of the author is indicated by printing the technical expressions in italics.

The grouping of the different mental states follows that in a general way advocated by the German schools, and is probably the most used for the purpose. It is, however, questionable whether the consideration of the various mental diseases of adolescence, which have been grouped under dementia precox, is scientifically or clinically correct. This tendency has led to the inclusion of certain mental states, more particularly under the paranoiac group, which had better be treated separately. For this reason a consideration of all these cases of dementia precox as abiotic forms of disease is decidedly open to question.

The pathology of the different forms of mental disease is carefully considered as far as the limited space permits. The statement, however, that the disappearance of the tangential fibers accounts, in a measure, for the dementia of the senile psychoses, is too sweeping a statement, and probably incorrect. In the atrophic processes seen in such a wasting disease as tuberculosis, the disappearance of the tangential fibers is not associated with any distinct dementia.

One cannot help feel that, while the publication of Dr. White's work will add to the value, and especially to the success, of the monograph series, it would be better if this work had been published in a more extended and stable form. It is to be hoped that we may have in the future a more extensive work upon the same subject and along the same lines by this author. The work is published on poor paper and in a paper binding. It is worthy of a more stable structure. D. J. McC.

PRACTICAL ANESTHETICS. By H. EDMUND G. BOYLE, M.R.C.S., L.R.C.P., Assistant Anesthetist to St. Bartholomew's Hospital, London. Pp. 178; 22 illustrations. London: Henry Frowde, Oxford University Press; Hodder & Stoughton, 1907.

THERE should be cordial welcome for any book which attempts to instill into the minds of students and junior hospital internes some of the principles underlying the use and administration of anesthetics, before they are in a position to make practical application of their ignorance of these principles. The manual now before us opens with a chapter on "general considerations," in which are discussed the duties of the anesthetist, examination and preparation of the patient; apparatus required; position of the patient; moving of the patient; and the after-treatment, as well as the subjects of shock, collapse, and artificial respiration. There follow chapters on nitrous oxide, on ether, on chloroform, and on ethyl chloride. The concluding chapters discuss the subject of mixtures and sequences of the various anesthetic substances; the question of the selection of the anesthetic for various operations; and the administration of the anesthetic with the patient in different positions—prone, lateral, high-pelvic, sitting, etc. Neither spinal nor local anesthesia is considered.

Nitrous oxide is recognized as the safest; and ether is in general preferred to chloroform. As Mr. Boyle tersely puts it, it is better that "patients should suffer from bronchitis after ether than that they should die on the table from chloroform." He thinks the safety of ethyl chloride has been exaggerated, and believes its dangers should be rated as equal to those of chloroform, because of the rapidity of its action and the liability to spasm. He prefers to induce anesthesia with nitrous oxide gas and oxygen, and maintain it with ether; if the operation is to be prolonged, he changes to chloroform after fifteen or twenty minutes. He advises the "closed" method of administering ether, condemning the "open" method so much used in this country in the following words: "The open method is only adaptable to children or to much exhausted patients. An attempt to anesthetize a robust patient by means of ether poured on lint would result in the formation of much snow on the lint, the using up of several half-pint bottles of ether, and would terminate in failure." Whether climate can make such a difference, we know not, but certainly no such difficulties attend the "open" administration of ether in this country; two ounces of ether has usually been sufficient in our own experience to induce anesthesia, and it usually can be maintained at the rate of about six ounces an hour, should the operation last so long. A. P. C. A.

PROGRESS

OF

MEDICAL SCIENCE.

MEDICINE.

UNDER THE CHARGE OF

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The Gastric Secretion in Old Age.—JULIUS FRIEDENWALD (*Amer. Med.*, 1908, xiv, 275) notes that most of the previous work of gastric secretion has been done with young adults. However, later work has shown and some authors have pointed out the occurrence of atrophic changes in the stomach as well as the disappearance of free HCl. This hypochlorhydria is supposed to be related to and proportionate to the degree of arteriosclerosis. After a review of the literature of the subject Friedenwald gives his observation in 27 persons, all over fifty-five years of age and none having symptoms of gastric disorder. Free HCl was constantly absent in 44 per cent., and in only 5 of the 27 was there a normal percentage of free HCl. In 18 of the patients who had arteriosclerosis, 10 showed an absence of free HCl, and the remaining 8 much diminution. Friedenwald concludes from his own observations, as well as those from the literature, that the gastric secretion has a tendency to diminish in old age and in a degree proportionate to the arteriosclerosis. It is, therefore, unwise to attach too much importance to the absence of this secretion in individuals advanced in years in the diagnosis of cancer of the stomach.

Tuberculin Inunction.—ERNST MORO (Munich) (*New York Med. Jour.*, 1908, lxxxvii, 1233) suggests a new tuberculin reaction by rubbing into the skin of the chest or abdomen an ointment made up of Koch's old tuberculin, 5 c.c., and anhydrus wool fat, 5 grams. A piece the size of a pea should be rubbed over an area of the skin about two inches square for about half a minute and allowed to become absorbed. Observation, which is usually best on the second day, reveals the presence of small papules over the area of inunction or thereabouts if the reaction is positive, and no change in the skin if

negative. The papules may be very pale and scarce, but occasionally are numerous and red. Exceptionally there is very much redness or itching. No local or general symptoms have been observed. The papules usually disappear at the end of a week. Moro says a positive result is as conclusive as that of the conjunctival or skin reactions. The only difference noted is that in advanced cases of tuberculosis the skin loses early its reactionary power to the inunction. In other cases that show no clinical signs of tuberculosis the percentage of positive results is much smaller in the inunction method. Another advantage of this method is that the applications are harmless when compared to the other reactions (the skin and eye), and the patients do not object to its use.

Continuous Inhalation of Oxygen in Pneumonia.—GEORGE STOKER (*Medical Press and Circular*, 1908, lxxxvi, 90) notes that oxygen when used late in the disease, when the patient is cyanotic and gradually sinking, is often useless, giving but temporary relief. He thinks that it is this delay that has brought discredit on oxygen as a therapeutic agent. For the continuous effective inhalation it is essential to use a gas bag holding one cubic foot of oxygen filled and refilled from the cylinder as needed. This prevents gas from being inhaled when too cold and also measures the exact amount of gas which may be given in a certain length of time. It requires usually about two hours to empty the bag when under slight pressure. A soft rubber nose piece should be used and its tip inserted into one or the other nostril, as when held before the patient's mouth in the usual method it is found useless. Stoker reports at length a case of pneumonia treated in this manner as outlined above, in which all the symptoms subsided and the patient made a complete recovery within nine days. He concludes that the best results will be obtained when the oxygen is given as soon as the disease declares itself, and that the inhalations must be continuous day and night and kept up as long as the symptoms persist.

Treatment of Gonococcic Arthritis by Injections of Dead Gonococci and the Clinical Reaction which follows the Injections.—E. E. IRONS (*Arch. Int. Med.*, 1908, i, 4333) gives the result of 40 cases of gonococcic infection inoculated with varying doses of the organisms, and concludes that in certain chronic cases the mechanism of immunity fails to rid the body of the organisms and they persist either in the original lesions or in one or more foci, thus giving rise to the new lesions in these cases. The injections seem to be of distinct value in these cases and of no harm. The dosage was at first 20,000,000 to 50,000,000 organisms, but later it was found advisable to increase to 100,000,000 and more. The interval between the injections varied from three to seven days. Further work and reports will enable one to give a more accurate dosage, and the percentage of favorable results, it may be hoped, will be greater. During the course of the injections the usual general therapeutic measures should also be tried. As a diagnostic procedure it may be of more use, as the reaction has many points in common with the tuberculin reaction; it should prove to be reliable (it must be tried in many more cases), and a valuable and much needed aid will be at hand for the diagnosis of obscure joint, synovial, and periosteal disease.

SURGERY.

UNDER THE CHARGE OF

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Radical Operation for Umbilical Hernia by Overlapping of the Flaps.—BRENNER (*Archiv f. klin. Chir.*, 1908, lxxxvi, 20) says that since Lawson Tait, in 1884, first proposed this operation, there have been a large number of them done, although they are not all reliable; and the proportion of operations done to the total number of cases is small and the recurrences still too frequent. Pott, in 1903, estimated the permanent cures from operation for inguinal herniæ to be 92 per cent., in femoral 92.5 per cent., and in umbilical 54.7 per cent. for all methods. His collected cases from the literature show 4066 inguinal herniæ, 424 femoral, and 86 umbilical. Brenner found about the same proportions in a collection of hospital cases operated on. The results of operation in umbilical herniæ depend in large measure upon the size of the hernia. Busse in the small herniæ (from the size of the hazelnut to that of a walnut) obtained 100 per cent. of permanent cures, in the medium sized (apple to a goose egg) 50 per cent., and in the largest (double fist to a man's head) 25 per cent. The average permanent results should be estimated from the large and median sized herniæ, in establishing the value of radical operation. The various methods of operation are discussed. The method which Brenner has employed is very similar to and probably identical with that published by Wreden in 1906, but which Brenner had done in 4 cases before that time. He has already employed it in 26 cases up to the present time, 19 umbilical, 3 epigastric, and 4 ventral. Lumbar anesthesia is preferred. A sagittal incision is made over the hernia, and in the upper part, where the covering is thin, an elliptical portion is removed. The sac is isolated, opened, and the contents properly examined and returned. The sac is removed and the hernial ring closed by several sutures which include the peritoneum and the aponeurosis. The mass of fat covering the aponeurosis between the edges of the recti is then removed. The inner borders of the recti are then carefully exposed through small incisions in their sheaths. They are often 10 to 15 cm. apart, and their separation narrows below to the symphysis and above to the costal arch. This elliptical field must be strengthened and the umbilical ring obstructed by the two flaps which are to be made from the anterior sheaths of the recti. The fat is first lifted from the aponeurosis over the recti in a curved field, convex outward, far enough so that a flap of aponeurosis can be lifted from over each rectus, its cut edge being external and its attached border internal. This semilunar flap must be large enough, so that

when it is separated by an arching incision along the outer margin of the exposed area and the flap is turned over toward the median line, it will reach to the inner border of the rectus of the opposite side. When both flaps are formed, the left one is turned over and its cut edge sutured to the inner attached border of the right flap, which is in turn inverted over the left. The elliptical area interposed between the separated recti is thus reinforced by these two new layers and the recti muscles are visible in their denuded areas. The skin flaps are then closed by sutures and drainage provided. In one case the wound was opened eight days after operation, and the flaps showed good nourishment. In another case from fat necrosis the edges of the wound separated, showing one of the flaps, which gradually became covered by granulations. Skin grafting was later performed and a permanent cure obtained. Of the 26 cases operated on, 3 died; 1 eight days after operation from a hemorrhage of a duodenal ulcer; a second three days after operation from necrosis of the transverse colon due to disturbance of the blood supply during the separation of the hernial ring; and a third case from septic peritonitis. The average course of the wound healing in the remaining 23 cases, was twenty-eight days.

Pulmonary Emboli after the Radical Cure of Inguinal Hernia.—MAUCLAIRE (*Archiv. gén. d. chir.*, 1908, ii, 573) says that the discussion of postoperative emboli has concerned itself chiefly with its origin in appendicitis. Pulmonary emboli have been reported as occurring in cases of strangulated hernia, and Mauclaire thinks that the emboli reach the systemic circulation, probably, through the anastomoses between the portal system and the inferior cava. Following the simple radical operation for inguinal hernia, they are rare enough to warrant the report of additional cases. Fifty cases from the literature are studied and one personal case reported. The etiology is the most interesting feature of the subject. The causes are divided into local and general. The local include the local infections; and lesions of the epigastric vessels, femoral vein, and spermatic vessels. The general include general infections, the condition of the blood and heart, the condition of the local veins or those of the rest of the body, and too early standing after operation. Local infections require first consideration. It has been shown to have been present in several cases. Some authors found the wound normal, but suspected the deeper parts. In Mauclaire's case it was evident that the embolus resulted from a phlebitis of the spermatic cord in consequence of the manipulations during the operation. It may be transferred to the opposite side by anastomotic veins. This phlebitis has been observed in cases of gonorrhœa and varicocele. Bruner observed it in 50 cases. In 400 or 500 radical operations done by Mauclaire in the past ten years, it was observed four or five times. It can be complicated by early or late emboli. The femoral vein may become involved in the course of the operation or the later dressings. The phlebitis develops sometimes on the side corresponding to the operation, sometimes on the opposite side, just as it does from appendicitis. In cases of femoral phlebitis consecutive to operation for inguinal hernia, the lesion of the epigastric vein may be the original cause, the phlebitis extending to the femoral vein. By the anastomoses between the epigastric vein of the two sides or by the obturator veins, extension

may occur to the opposite side. Pulmonary embolus in these cases is often fatal. The palliative treatment consists in avoiding or treating the local or general causes.

The Treatment of Acute and Subacute Suppurations by Bier's Passive Hyperemia.—HEINRICHSEN (*Archiv. f. klin. Chir.*, 1908, lxxxvi, 158) says that his first results from this treatment led him to be skeptical of its value. These results were dependent partly upon a faulty technique, and partly upon cases unfavorable for the method. The constricting bandage should be applied either to the arm or thigh. The turns should not completely cover each other, but should surround the greater part of the limb, and the position should be changed somewhat at each application, if possible. The rubber bandage was protected underneath by a thin cotton bandage on the thigh, but on the arm no such protection was employed. Care, however, was observed not to permit wrinkling of the bandage, which might cause the formation of blisters. The passive hyperemia was continued twenty to twenty-two hours daily in acute cases, and ten to twelve hours in the subacute. For the shoulder-joint it was kept up only ten hours. Around the neck, a bandage 2 to 3 cm. broad was employed. Cupping apparatus was applied forty-five minutes to one hour. It may be applied for five minutes, then removed for two to three minutes, and re-applied for five minutes. In all, 178 cases were treated, 103 only by cupping, 71 by bandage, and 4 by a combination of both. The results showed that, under certain conditions, passive hyperemia in acute inflammations gives good results in a shorter time, and is to be preferred to a wide incision. To avoid failure the hyperemia must be given in proper dosage, the patients must be under continual observation and the wound not tamponed. The temperature after this treatment usually falls by crisis, rarely by lysis. In many instances there will be no inclination of the temperature to fall, but this is not an indication for a wide incision. Good results are obtained in cases of recent wounds and operations, in which infection is suspected.

Osteoplastic Filling of the Defect after Resection of the Lower Jaw with a Piece of Rib by Means of a Pedicle Flap from the Chest, or by a Free Transplantation.—PAYR (*Zentralbl. f. Chir.*, 1908, xxv, 1065) has for some years been filling the defect by different kinds of prosthetic apparatus, made of magnesium. This consisted either of a splint made of magnesium plate, or a strong magnesium wire. These were suitably bent and introduced into holes made in the ends of the resection stumps, or, if a resection had been done on one side, the apparatus was attached by holes on the surface of the articular tubercle. He says that he would employ now such an apparatus carrying a metal head corresponding to the glenoid cavity. For the substitution of a resected middle piece of the jaw he advises a splint made of magnesium wire with two clasps attached to its ends, which are to be fastened by wire or screws, placed in holes bored in the resection stumps. This apparatus is applied easily, keeps the bones in good position, requires small space, and favors an exact closure of the cavity of the mouth. In one such case, in which the wire was employed, in ten days a complete water tight protection of the wound from the mouth was obtained. The plate has the

disadvantage that its sharp margins produce a secondary necrosis of the mucous membrane by pressure. In most of the cases the wire was removed in from seven to ten weeks, and was replaced by a dental substitute. In one case the magnesium apparatus healed in without a fistula, and was completely absorbed and replaced by a thick and cosmetically sufficient scar. Only isolated attempts have been made to fill the defects by osteoplastic methods. No appropriate osteoplastic method has yet been developed for the different requirements, and brought into general use. Payr, for several years, has been considering the advisability of employing a piece of rib covered by periosteum for this purpose. This may be accomplished in one of two ways. A piece of rib of suitable length may be resected through a small incision below the clavicle, and then displaced between the skin and fascia to a new position, from which the skin and fascial flap is to be taken later. The concavity of the resected piece is made to look toward the skin. After two or three weeks, a new vascular supply is established between the piece of rid and the surrounding tissues. In the second operation the diseased portion of the jaw is removed and is replaced by the rib carried in a long, wide, tongue-shaped flap of skin and fascia, the piece of rib being fastened into the defect in the jaw. Finally, the skin flap is employed to fill in defects in the mucous membrane or skin, or it is replaced in its original position. A second method is by the free transplantation of a piece of rib into the defect. Payr has employed the first method in 2 cases and the second in 1, with good results.

The Pathology of Cholelithiasis.—EXNER and HEYROSKI (*Archiv f. klin. Chir.*, 1908, lxxxvi, 609) say that bacteria in the bile, by their growth, decompose glycocholate and taurocholate of sodium, as well as other biliary salts. Then the cholesterin is not held in solution, be cause of the absence of these salts. Some bacteria are especially capable of producing this decomposition, and are therefore especially prone to give origin to stone formation. Even in bile sterile for a long time decomposition of the biliary salts can occur. The soap and fat contained in the bile play no part in the development of cholesterin. The bodies in the bile, considered up to the present time to be fatty acids, actually contain only a small proportion of fatty acids. The proportion of these acids in the bile is actually, approximately, only one-tenth of what it has been supposed to be. These facts are of much importance in connection with the origin of gallstones, since they show that bacterial infection of the gall-bladder must result in cholesterin formation and thus give cause for the formation of cholesterin calculi.

The Development of Weight-bearing Stumps, by Means of Hirsch's After-treatment, in the Japan-Russian War.—HASHIMOTO and SAITO (*Archiv f. klin. Chir.*, 1908, lxxxvi, 589) report the results of amputation of the lower extremity in 38 cases, in some on both sides of the body. The after-treatment consisted in elevation of the limb, massage several times daily, wrapping the limb in cotton after the massage, treading exercises, a lysol bath every evening, standing several times daily upon a provisional apparatus the cavity of which was filled with cotton, and walking exercises upon this apparatus. Amputation is one of the most important operations in military surgery. Upon the battle

field, every aid should be provided, in order to avoid crowding of the wounded men. All efforts must be made to transport the wounded, the wound put in as favorable a condition as possible, so that infection and hemorrhage in transport shall be avoided. Hashimoto and Saito recommend a quick and simple amputation on the field of battle, by the circular incision through the bone or joint. The stump will not be at once weight-bearing. The osteoplastic operations, having for their object an early weight-bearing stump, are too troublesome or dangerous for employment on the battlefield. When a rapid amputation is necessary as on the battlefield, the circular method with the Hirsch after-treatment, is recommended. This gave good results in their 38 cases. When time during the operation is not a factor, and a choice can be made of a method which will give undisturbed wound healing, then the stump should be selected which will soonest bear weight.

Tetany following Thyroidectomy Cured by the Subcutaneous Injection of Parathyroid Emulsion.—BRANHAM (*Annals of Surgery*, 1908, xlviii, 161) reports a case in which a goitre was removed from a girl, aged fourteen years. Although an effort was made to avoid the parathyroids, it was afterward shown that some parts were removed with the gland, some remaining. The patient was apparently making an uninterrupted recovery, until eighty-eight hours after the operation, when the teeth became clinched. Shortly afterward the hands became contracted and the feet affected (talipes equinovarus), wrists flexed on the forearms (full flexion) and the forearms slightly flexed on the arms (at right angles). Reflexes were not exaggerated, no elbow or wrist jerk. The head was thrown back, teeth clinched, but the face not distorted. Only her head, shoulders, buttocks, and heels touched the bed. The temperature was 38.5° C., and the symptoms toward the last of the attack were alarming. There were distinct exacerbations like those of tetanus, during which the pulse was rapid and the respirations difficult. Thyroid extract in doses of 0.192 gram were ordered every three hours, and every four hours she was given 0.0648 gram of parathyroid extract. No relief followed, but the contractions became more marked. On the following day, six raw, fresh beef parathyroids were forced into the mouth and they were swallowed. This was repeated on the next morning and night. The symptoms became more pronounced. On the same night, five of the glands were placed in a 1 to 1000 bichloride solution and allowed to soak ten minutes. Observing strict asepsis, the glands were cut into fine pieces under physiological salt solution. These pieces were placed in a mortar and ground into a homogeneous mass, 400 c.c. of sterile salt solution being added. This was then filtered through sterile gauze and given as a transfusion into the patient's breast at 10 P.M. At 1.30 A.M. on the following morning, she was asleep and the contractions were becoming less violent. They disappeared in her hands, arms, and face by 10 A.M. and her lower extremities were nearly relaxed. The temperature dropped from 38.5° C. at 8 P.M. on the second day after the beginning of the attack to 36° C. on the third day. There were no more contractions until the fifth day, when there was a recurrent attack lasting twenty minutes, and involving only the face. This was succeeded by milder attacks which lasted until about 11.30 P.M. at which time she was given two parathyroids subcutaneously in 100 c.c. of salt solution. The attack

ceased almost immediately, and the patient has remained free from any symptoms of tetany up to the present time, more than a year after the operation. The permanent results are probably due to the fact that parathyroids were not all removed. The parts left were undoubtedly so damaged by the traumatism of the operation that their functions were suspended; but as they recovered, their normal work was resumed and possibly compensatory hypertrophy was secured.

Musculospiral (Radial) Paralysis Due to Dislocation of the Head of the Radius.—STETTEN (*Annals of Surgery*, 1908, xlviii, 275) says that musculospiral paralysis as a result of dislocation of the head of the radius is a distinct type of nerve injury, and is quite as definite and characteristic as any other form of injury to this nerve. In fact, in every case of anterior dislocation of the head of the radius the two divisions of the musculospiral nerve are in danger and it is a fortunate accident if they escape. Its actual occurrence is naturally rare, but comparatively, that is, compared to the frequency of the joint injury itself, it is not infrequent. It is most likely to occur when the dislocation accompanies ulnar fracture and when the direction of the dislocation is forward and slightly outward. The nerve is almost invariably injured below its point of division into the posterior interosseous and radial. One or both branches may be caught by the dislocated head. The symptoms are practically those of the typical musculospiral palsy. They may vary greatly in extent or degree, depending upon whether one or both nerves be injured and how badly. The supinator longus muscle escapes involvement. The prognosis is good under appropriate treatment, which is practically the same as that for the dislocation: simple reduction, if possible, and generally resection of the head of the radius in old cases, with nerve suture if necessary. Should the nerve be uninjured in a dislocation of the radial head, its close proximity to the head of the bone should be borne in mind, the dislocation should be reduced, and care should be exercised not to injure the nerve by pressure, hyperextension, or careless operative technique.

THERAPEUTICS.

UNDER THE CHARGE OF

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Clinical Observations on the Intravenous Use of Strophanthin.—LUST and HOEPFFNER (*Deut. Arch. f. klin. Med.*, 1908, xcii, 282, 485) relate their experiences with the intravenous use of strophanthin. Lust gives detailed histories of some especially instructive cases; Hoepffner bases his conclusions on observations in 34 cases. Both consider the action of

strophanthin very similar to that of digitalis, but stronger and more prompt. Lust's conclusions are as follows: (1) Acute cases of cardiac insufficiency in which digitalis works too slowly can be favorably influenced in a few minutes by a single injection of strophanthin; occasionally a second dose may be necessary. (2) A diminution of the pulse-rate with an increase in the size of the individual beats occurs in a few minutes, increased diuresis follows after a few hours, and the general condition improves. (3) Given in combination with digitalis it serves to increase and maintain the digitalis stimulation; for this purpose it should be given in small and repeated injections. (4) It should be given in doses of 0.5 to 1 milligram; often 0.3 milligram will be sufficient to begin with. (5) To prevent a cumulative action, injections of 1 milligram should not be repeated oftener than once in twenty-four hours. (6) It is of no therapeutic value in nephritis when other diuretics fail; it may be of diagnostic value and point the way to subsequent therapy in those cases in which it is doubtful whether the insufficiency is cardiac or renal. (7) It is of no value in pneumonia.

In five cases of pneumonia, Hoepffner saw improvement of the circulation only once. From this he does not draw any conclusions; furthermore, he thinks strophanthin was probably given too late. He also suggests, as an additional reason for its failure, that in pneumonia the paralysis of the vasomotor system is the chief cause of the failure of the circulation. Hoepffner observed two cases of acute heart failure during convalescence after infectious diseases, in both of which the subjective and objective symptoms promptly disappeared after the injection of 0.5 milligram of strophanthin. In pulmonary tuberculosis no diminution of pulse-rate was obtained, although the size of the pulse seemed increased. Hoepffner sums up the indications for the use of strophanthin as follows: (1) Severe cardiac insufficiency, in which digitalis has lost its effect. (2) To re-inforce digitalis therapy and to shorten the period of use of digitalis. (3) Cases of cardiac insufficiency in which other means have failed.

With regard to bad results, chills at first were frequently observed, but since the perfection of the preparation for intravenous use they no longer occur. Lust had one case in which death occurred fourteen hours after an injection of 1 milligram. He thinks this death had no connection with its use. Hoepffner had two fatal cases. One died three minutes after the injection of 1 milligram, too short a time for any poisonous drug action. This case was a severe case of failure of compensation, and he thinks death was coincident with the injection, but not caused by it. The second case (one of the early ones), died during a chill. He thinks this death could now be avoided with the perfected preparation.

The Use of Fresh Animal Sera in Hemorrhagic Conditions.—LEARY (*Boston Med. and Surg. Jour.*, 1908, iii, 73) says that the power of blood sera and tissue juices to promote coagulation has been known for some time to physiologists. The practical application of this knowledge is due largely to the work of Weil, who first used fresh animal sera in hemophilia. Weil's work brought out these facts: That the blood serum of horses, of rabbits, and of beef creatures, as well as human serum, would control hemorrhages by increasing the coagulability of the

blood; that beef serum was too toxic for ordinary use; that the serum should be less than two weeks old; that a dose of 15 c.c. intravenously or 30 c.c. subcutaneously would usually obtain results; that the local use of serum favored clotting, and that the increased coagulability persisted for fifteen days to several weeks. In hereditary hemophilia the results, at best, were temporary; repeated injections were necessary to control hemorrhages, and the greatest value of the treatment lay in the prophylactic injection of serum before operative procedures. In sporadic hemophilia and acute purpura the cures were usually permanent.

Diphtheria antitoxin has been used with variable results in the control of hemorrhages, probably because of the difficulty of obtaining a fresh antitoxin. It seems that commercial antisera are subject to the same objections. Leary advises rabbit serum, which should be less than two weeks old. He prefers to use it subcutaneously, since the dangers of hemolysis and thrombosis (although remote) are to be considered in the intravenous use. The latter, he believes, should be limited to extreme cases or to those in which human serum is used. The toxic action of horse or rabbit serum is slight, although beef, goat, and sheep sera are often notably toxic. Although rare in human beings, the danger of anaphylaxis, when it is necessary to repeat the injection, is to be considered. As a rule, however, only one injection is required. In one case, when the bleeding was repeated, guinea-pig serum was used for the second injection. Leary had no evidence of toxic action, other than one case of urticaria. From his observations he believes that the serum also acts as a cardiac stimulant. From a series of twenty cases he does not attempt to draw definite conclusions, but believes that the results of Weil, with his own cases, suggest a wider use of sera in the control of hemorrhage, especially its prophylactic use before operations.

Milk-free Diet in Typhoid Fever.—SEIBERT and STRONG (*Medical Record*, 1908, xxv, 1017, 1018). Seibert has used milk-free fluid diet in 61 cases of typhoid fever, with only 1 death. His routine is as follows: An initial calomel purge, two grains repeated in two hours. For the first twenty-four hours cold water only is given by the mouth. Rectal irrigations of three pints of warm water are given every three hours in severe cases, in average cases every six, and in mild cases every twelve hours. Intestinal hemorrhage, appendicitis, and perforation are the only contraindications. One-half pint of strained rice, oatmeal, or barley soup, containing the extract of one-half pound of meat and egg yolk, is given every three hours. The patients are not urged to take the full amount, but only as much as is palatable. They are made to drink freely of cold water. At the fifth or sixth day the patients usually desire more food, and this is met by making the soups thicker. About this time strained pea, lentil, potato, and tomato soup with rice are added. At the end of a week, two or three pieces of zwieback are given if the patients are hungry. No egg albumin is allowed, because of the possibility of formation of toxins. Diluted hydrochloric acid is given before the feedings. No alcohol is necessary unless the patient is accustomed to its use. The results of this treatment, Seibert thinks, are that the mortality is reduced, the attack is shortened, most of the patients convalesce much sooner, complications are diminished, and both the intestinal and nervous symptoms are ameliorated. In his series of cases the nausea,

headache, delirium, insomnia, tympanites, and diarrhœa disappeared in two or three days and did not recur. In the majortiy of cases the temperature reached normal on the ninth to the twelfth day of the treatment. In a smaller number of cases this occurred within the first week. In cases admitted with complications, these disappeared more readily than under the former milk diet. Strong has treated seventeen cases, and thinks very favorably of this mode of treatment. He believes it eliminates fermentation, one of the principal sources of danger. He uses broths, crackers, zwieback, gelatin, rice, etc. His results were: There was less prostration, the tongue remained moist and clean, there was no tympanites or diarrhœa, and the patients maintained their weight better.

Antityphoid Inoculation.—SANBORN (*Boston Med. and Surg. Jour.*, 1908, clviii, 864) states that statistics show that the incidence of typhoid fever among inoculated individuals is about one-half that among those not inoculated, and that among those who contracted the disease after inoculation is about one-half that in subjects who contract the infection and are uninoculated. As to the reasons for the incidence of the disease in those inoculated we may speculate that in some instances there was insufficient response to the vaccine given, in the formation of protective substances; in some it is possible that improper dosage may prevent the induction of protection; in some infection may have taken place during the period of diminished resistance that experiment has shown follows the injection of any bacterial vaccine of sufficient dosage to later cause an increase in antibacterial substances. At this period there must be greater suspeptibility to infection. In other individuals inoculation may have been given after infection had taken place, but before the development of symptoms. The danger of the inoculation of a properly made vaccine, standardized and given in proper dosage, should be nothing and the subsequent symptoms are not to be dreaded. The protection achieved may continue for two years or more.

Antityphoid Inoculation in the British Army.—LEISHMAN (*Military Surgeon*, 1908, xxii, 421) gives the results of antityphoid inoculation in the British Army in India as follows: Non-inoculated, 8113. Of these 173 individuals contracted the disease and 42 died. Incidence per 1000, 21.32; mortality per 1000, 5.18. Inoculated, 2207. Of these 15 contracted the infection and 3 died. Incidence per 1000, 9.80; mortality per 1000, 1.36. The duration of the immunity conferred cannot yet be said to be established. Much importance is attached to the possibility of the development of a negative phase of resistance to infection following inoculation, but it appears that the dangers of this phase are more theoretical than real. Now and then a subject will be inoculated who is in the incubation period of the disease, but, apart from this, there seems to be no evidence that recent inoculation increases the liability to infection.

Vaccines in Tuberculosis.—WEBB (*Ill. Med. Jour.*, 1908, xiii, 607) has used, in this form of treatment, almost entirely Koch's new tuberculin. The initial dose has never been greater than $\frac{1}{1000}$ mg., and

often as low as $\frac{1}{1000000}$ mg., a dose which has been shown capable of producing a positive phase. Upward of 60 patients, chiefly of pulmonary tuberculosis, have been inoculated with gradually increasing doses up to not exceeding $\frac{1}{800}$ mg. at intervals of from seven to ten days. In all patients the opsonic index has been determined to eliminate any possibility of auto-inoculation, but the index has not been used as a guide to time for inoculation, but only as a test to ascertain if the desired effect has been brought about. The results have been most pleasing, showing a distinct gain over former results obtained by a combination of climatic and sanitorium treatment without tuberculin inoculations. The results from the use of Koch's new tuberculin have been most favorable, no bad effects having been noted in any subject. Several moderately advanced infections have been apparently cured. Many seem to have been arrested from an active condition which rest and climate alone could not achieve. Febrile patients have been rendered afebrile, and especially when tuberculin has been combined with mixed vaccine, marked alleviation of cough, and expectoration has been common.

The Treatment of Intermittent Lameness.—KOLMER (*Univ. Penna. Med. Bull.*, 1908, xxi, 80) considers the treatment of this condition in most instances unsatisfactory. If there is a syphilitic element, a thorough course of mercury and the iodides may both arrest progress and relieve symptoms. Potassium iodide may be given in the belief that it is a vascular stimulant and promotes the flow of blood through the vessels, thus furnishing the muscles with the needed blood. If arterial tension is high the nitrites should be prescribed. Alcohol, tobacco, overexertion, and exposure should be avoided, and massage and passive movements, mud, and other warm baths with galvanism to correct vasomotor irritation, together with the correction of flat foot, if it exists, offer some hope of success.

The X-rays in Lupus.—TOMKINSON (*Practitioner*, 1908, lxxx, 817) quotes Gaucher as stating that phototherapy gives very good results in the two varieties of lupus. It has the merit of giving in general, beautiful cicatrices, but it is a long and costly process, not within the reach of everybody and is not applicable to every region. The Finsen method remains at present the best. Radiotherapy has an analogous action to, but more intense than, phototherapy upon tuberculous lupus. It is more difficult to control. Tomkinson is accustomed to employ for facial lesions a combined treatment, which so far has given good results. The technique is as follows: Crusts are removed by a salicylated ointment. A tentative *x*-ray exposure of from three to five minutes is made upon a small area of the lesion. In a few days the rays are directed for about five minutes daily upon a wider area until the whole lesion has been exposed some three or four times. It is then plastered with Unna's 50 per cent. salicylic acid and creosote plastermulle, which is renewed daily. If this is badly borne the lesion is previously swabbed with 10 to 20 per cent. cocaine. In about ten days much of the tuberculous tissue will have come away. The lesion is then swabbed with cocaine solution, dried and painted with phenol, 0 parts; lactic acid, 15 parts; salicylic acid, 15 parts; absolute alcohol,

20 parts. A few minutes later the lesion is painted with phenol, 80 parts; absolute alcohol, 20 parts. After cauterization a dressing of 1 to 30 carbolic oil is applied for a day or two, to be followed by 20 per cent. aqueous solution of ichthyol until healing has taken place. Subsequent similar courses of treatment are sometimes necessary.

Camphoric Acid.—TYRODE (*Boston Med. and Surg. Jour.*, 1908, clviii, 908), after having performed over 100 experiments upon animals with this substance, concludes that camphoric acid as such acts in the same manner as other organic acids which are not decomposed in the body, that in combination as a sodium salt, which is formed in the intestines, it acts like any neutral salt, such as sodium sulphate, that is, its ions have so little activity that it possesses only the action derived from its physical properties, "salt action." He further sees no justification in its use as a respiratory and heart stimulant, nor as an anhydrotic in the night sweats of tuberculosis. Yet it may be of some utility as a urinary antiseptic, because it may have, in common with many other free organic acids, slight antiseptic power.

Results of Treatment of Epidemic Meningitis with Flexner's Serum.—SLADEN (*Johns Hopkins Hospital Bull.*, 1908, cciv, 245) says that during the years 1889 to 1907 there were 33 cases of epidemic cerebrospinal meningitis treated at the Johns Hopkins Hospital, of these 21 died and 12 recovered, a mortality of 64 per cent. In 1908 there were 19 cases, all of which received the Flexner antimeningococcic serum. Of these, 16 recovered and 3 died, a mortality of 16 per cent. Of the cases that died, 1 was fulminant; 1, a child aged twenty-nine months, was admitted on the fourteenth day of the disease and died forty-eight hours after admission; the third was a stout colored woman with a complicating bronchopneumonia, who died forty-eight hours after the first dose. Most of the cases were temporarily upset by the injections, complaining of pain, usually in the knees, occasionally in the hips, and on two occasions pains about the rectum and a desire to defecate. The pains lasted from two to ten hours after the injection. Following the injections there was usually a slight rise in temperature and increased restlessness. Urticaria and erythematous eruptions were not infrequent. Usually there was an interval of from twelve hours to three days before any improvement of symptoms. Some of the cases required only one injection, others as many as six. The serum was given daily until the temperature became normal, and if there was any recrudescence of the fever, the serum was again used. By this treatment there was obtained a fall of temperature, often by crisis; an early subsidence of delirium; the headache, the pain in the neck and back, and the general hyperesthesia were much alleviated. Strabismus, stiffness of neck, and Kernig's sign were more persistent. An increase of the polymorphonuclear neutrophiles was noted in the spinal fluid after the injections, and the meningococci seemed to become more intracellular.

Poisoning by Bismuth Subnitrate.—MEYER (*Therap. Monatsh.*, 1908, viii, 388) cites three cases of death resulting from large doses of bismuth subnitrate. In 1906 Benneke and Hoffmann reported the death of an infant who had been given 3 to 4 grams of bismuth in 100 c.c. of butter-

milk; it was supposed that the poisoning was due to some chemical change caused by the lactic acid, though this did not explain the methemogobinemia found at autopsy. Böhme (*Arch. f. path. Pharm.*, 1907, lvii, 441) reported the sudden death of an infant who had been given bismuth emulsion by mouth, and after an interval of two days, several grams by rectum. Three hours after the rectal dose she was seized with abdominal pains and diarrhœa, accompanied by steadily increasing cyanosis and marked dyspnœa. The heart was markedly overacting and the pulse was small and feeble. Death occurred in half an hour. At the autopsy traces of nitrous acid were found in the blood and pericardial fluid, though no metallic bismuth was found in the blood or liver, as had been the case in Benneke's patient. Böhme, by chemical means and by experiments on animals, established that nitrites can be formed from bismuth subnitrate in sufficient quantities to cause death. He found that human feces, and especially that of infants, was capable of reducing nitrates to nitrites. From this he thinks that it is possible for nitrites to be formed in poisonous amounts when large amounts of bismuth subnitrate are brought in contact with feces rich in bacteria, but, at the same time, that ordinary therapeutic doses do not have this effect. Meyer's own case was a man, aged twenty years. Three hours after a dose of 50 grams of bismuth subnitrate, given for radioscopic examination, he suddenly became markedly pale and cyanosed with all the symptoms of collapse. He was freely stimulated, but died in a few hours. In a note there is also an account of three other cases who recovered after alarming symptoms of similar nature. To prevent this Meyer advises that bismuth carbonate be used. Bismuth hydroxide has been suggested, but this does not remain in suspension long enough to permit the necessary examination.

OBSTETRICS.

UNDER THE CHARGE OF

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The Prognostic Value of Changes in the Blood in Puerperal Diseases.—GRÄFENBERG (*Archiv f. Gyn.*, 1908, Band lviii, Heft 2) concludes a very interesting study of this subject. The absolute leukocyte count and the leukocyte curve do not give positive indications as to the severity of a puerperal complication. When the leukocyte curve is recorded for a long time it gives information of comparative value in connection with other symptoms. When the neutrophiles are greatly increased they indicate a condition seriously threatening the organism, and when polyneucleosis in high degree is present, if for a long time, it indicates severe disease. When the neutrophiles are above 70 per cent. and the leukocytes above 10,000, it is safe to infer that suppuration has occurred. Exceptions, however, to this rule are observed and must

be kept in mind. The eosinophiles disappear from the consideration of the blood when a severe puerperal infection develops, and coma again under observation when the disease has reached its highest point. They are of no value as indicating the severity of a condition or its probable fatal termination. The eosinophile leukocytes are of value in puerperal gonorrhœa, in which their increase or their failure to disappear points out the nature of the infection. An increase in the large lymphocytes indicates an unfavorable prognosis, while an increase of the small elements points toward an improvement in the patient's condition. When there is a reversal of the usual relation between the two forms, the indication is unfavorable. In convalescent patients there is a characteristic lymphocytosis, sometimes reaching 73 per cent. of which 69 per cent. were small lymphocytes. When the increase is in the large lymphocytes only, the indication is unfavorable. The neutrophile appearance of the blood shows a lessening of the nuclei. This is most pronounced in fatal cases of purulent peritonitis. When the nuclei increase rapidly the prognosis is favorable. In severe puerperal gonorrhœa the nuclei curve is very little, if at all, less than normal. Attention is called to the importance of not laying too much stress on the nuclei curve alone in the matter of prognosis; other facts relating to the blood must be taken into consideration; especially important is the curve of the small lymphocytes.

Axillary Mammary Glands.—KAYSER (*Archiv f. Gyn.*, 1908, Band lviii, Heft 2) reports 4 cases with illustrations of axillary mammary glands. As a rule the patients were but little inconvenienced by this anomaly when not in a pregnant condition. In some cases slight pain was occasionally experienced by movements of the arms during menstruation; and some patients complained of neuralgic pains. In one instance severe neuralgia of the brachial plexus during menstruation was cured by the removal of the axillary mammary glands. During the last months of pregnancy patients sometimés suffer from the swelling of these glands. During the puerperal period they often become exceedingly tense and give rise to considerable pain. The swelling is greatest from the sixth to the eighth day, disappearing from the tenth to the twelfth day. In one instance primary carcinoma developed in one of these glands.

So far as treatment is concerned they require no interference unless they become excessively painful, or show evidence of infection or malignant development. From the standpoint of embryology they result from the excessive development of gland tissue along the mammary ridge of the embryo.

GYNECOLOGY.

UNDER THE CHARGE OF

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Preservation of the Ovaries Entire or in Part in Supravaginal Amputation or Panhysterectomy.—REUBEN PETERSON (*Amer. Jour. Obst.*, 1908, lvii, 633), after a careful study of 173 cases of his and a review of the literature, states that at least 10 per cent. of all women regularly menstruating at the time of operation will be free from the troublesome symptoms of the artificial menopause after hysterectomy with removal of the ovaries. The percentage of women with no symptoms after similar operations will be slightly more than doubled if some ovarian tissue be retained. The severity of the symptoms of the artificial menopause is much less when the ovaries are retained after hysterectomy. It is not necessarily true that the younger the woman the more will she suffer from the symptoms of the menopause, after hysterectomy with removal of the ovaries. The greatest percentage of suffering occurs in women operated upon between the ages of forty and forty-four years. Therefore, the rule that ovaries should be removed from patients over forty when hysterectomy is performed should not be followed. The frequency and severity of the artificial menopause is not influenced in any way by the kind of hysterectomy performed, whether the ovaries be removed or retained. The severity of the symptoms of the menopause is practically the same after hysterectomies with removal of the ovaries for fibroid disease of the uterus and inflammatory disease of the appendages. Retention of ovarian tissue after hysterectomy cuts short the pe iod during which patients usually suffer from the symptoms of the artificial menopause. The greater the amount of ovarian tissue conserved, the more will the symptoms of the artificial menopause be mitigated.

Transplantation of Ovaries.—F. H. MARTIN (*Surg., Gyn., and Obst.*, 1908, vii, 7) reports 3 cases of heterotransplantation and 5 of homotransplantation, all of which he had done. After giving a thorough review of the literature of the subject he draws the following deductions: The operation of homo- or heteroplastic transplantation of the ovaries in women, or in lower animals, is no more dangerous if accomplished aseptically than any other small plastic operation on the appendages. Homotransplantation of ovaries in women, or in lower animals, will prevent the atrophy of the genitalia which usually follows castration. It is not yet satisfactorily demonstrated that heterotransplantation of the ovaries in a considerable number of cases will give permanent relief from the nervous symptoms produced by the menopause or prevent atrophy of the genitalia otherwise following castration. Heterotransplantation of ovaries in women, or in lower animals, may prevent the atrophy of the genitalia which usually follows castration. Transplantation of ovaries from one species into another may result in pre-

venting ordinary changes in the genitalia resulting from castration. Menstruation will continue in women and monkeys after homoplastic transplantation of ovaries. Conception has followed homotransplantation in animals, heterotransplantation in animals, homotransplantation in women, and has been reported following heterotransplantation of the ovaries in women. Heterotransplantation of the ovaries should be accomplished as soon after the primary operation, in which the receptor's ovaries have been sacrificed, as possible, before the menopause has become established and the genitalia atrophied. Transplanted ovaries in localities other than the normal will maintain their vitality, functionate, and prevent the ordinary sequels of castration.

Eversion of the Uterus.—Pierre Delbet (*An. de gyn. et d'obst.*, 1908, v, 329) describes the case of a multipara, aged forty-two years, who had been in his care during this attack of illness; he had frequently examined her believing the condition was that of a sloughing fibroid. At the operation he found the mass to be the inverted uterus. Delbet maintains that as the infolding began at the cervix and proceeded from there instead of from the fundus it should be called eversion and not inversion of the uterus.

Fallacies of Intra-abdominal and Atmospheric Pressure as Supports of the Uterus and Abdominal Organs.—Channing W. Barrett (*Surg., Gyn., and Obst.*, 1908, vi, 369) carefully considers this subject and by experimentation attempts to disprove the opinions held by various authors on it. Barrett's conclusions are: When lax ligaments allow abdominal organs to make undue strain upon the pelvic floor, bulging the lower part of the abdomen, the air would be pressing inward at the epigastrium and diaphragm. The abdominal organs are not held together, surface to surface, so that it is difficult for one to leave another. One moves as easily away from the other, and something else moves in to take its place, as though they were in a sac of mosquito netting. The uterus is an abdominopelvic organ and not a part of the pelvic floor. It lies normally above the pelvic floor and not against it, but is attached to it by means of the vagina. If the vagina is to be considered a ligament, it must be for support of the pelvic floor or to prevent ascent of the uterus. The uterus may come to lie upon the pelvic floor, but so may the other abdominal organs. The pelvic floor is, then, only indirectly a support to the uterus, as it is to other abdominal organs. With a weak pelvic floor we may have hernia of abdominal organs; first the bladder and rectum, then the uterus, and then other organs. The uterus is primarily supported by its ligaments, but may be partially carried by fluid pressure, or may be pushed downward by solid structures. With a weak pelvic floor the bladder, rectum, uterus, and ligaments may be called upon to do this work of the pelvic floor, and may succeed for a time, but are apt to rebel sooner or later and prolapse, especially with excessive intra-abdominal pressure. The pelvic floor is a very important structure in abdominal support. Injuries to this structure are often responsible for displacements of the uterus. When displacements have occurred, however, orthopedic work upon the ligaments is usually as necessary as repair of the pelvic floor for permanent relief; neither alone

is sufficient. The uterine ligaments, being the normal support of the uterus, should receive our attention when surgical work is necessary, rather than the creation of false ligaments. In increased intra-abdominal pressure, much may be accomplished by remembering that the contents of the abdomen are too great. Diet, exercise, massage, and appropriate positions, will accomplish much.

Primary Carcinoma of the Female Urethra.—L. S. McMurtry (*Annals Surg.*, 1908, xlvii, 1032) reports 2 cases and has collected 25 others in the literature. McMurtry states that early diagnosis of primary cancer of the female urethra is extremely difficult owing to its close resemblance to caruncle and syphilitic lesions. The treatment in early cases is surgical ablation. In 1 of his 2 cases the operation has been done over one year and no recurrence is evident.

Adeno-fibro-myxo-chondro-sarcoma of the Cervix Uteri.—Puech and Massabuau (*Ann. de gyn. et d'obst.*, 1908, v, 306) report a tumor of this kind removed from a nullipara, aged fifty-nine years. The menopause occurred at forty-six years, and four years later at stool she passed from the vagina a piece of tissue and considerable blood. Three years later Puech removed the grape-like tumor by severing the pedicle and applying the thermocautery. This tumor proved to be sarcomatous. Five years later, symptoms returning, an examination revealed another tumor; this was removed by hysterectomy and proved upon microscopic examination to be an adeno-fibro-myxo-chondro-sarcoma.

Ectopic Pregnancy in the Stump of an Excised Tube, causing Attacks of Intestinal Hemorrhage.—H. M. Vineberg (*Amer. Jour. Obst.*, 1908, lvii, 527) reports the case of a woman, aged thirty-three years, who had been married fifteen years and had had three children and several induced early abortions, and in September, 1908, the left adnexa removed for ovarian abscess. Pain in the region of the stump of the appendage persisted. During the two months preceding the first visit to Vineberg, November 13, 1907, she had had seven attacks of severe hemorrhage from the rectum, attributed to hemorrhoids, and menstruation was absent for a corresponding time. An examination revealed a mass attached to the left uterine cornu and which was diagnosticated as a foreign body left at the operation. Three days later an operation revealed an unruptured pregnancy in the stump of the left tube, a part of the sac intimately adherent over a large area to the sigmoid. No opening between the two structures could be found. The sac was incised and contained a small amount of blood and an amniotic sac containing a fœtus of eight weeks' development. The right adnexa were buried in adhesions and the right ovary contained a good sized corpus luteum. Vineberg found in a literary research but one case (J. C. Morfit, *Med. News*, 1900, lxxvi, 869) resembling this one; he mentions Keller's case (*Des grossesse extra-uterine*, Paris, 1872) of tubal pregnancy with fatal termination occurring subsequent to a supravaginal amputation of the uterus by Koeberle (Winckel, *Handbuch der Gebür.*, vol. ii, 859); Wendeler's (*Beit. z. Geb. u. Gyn.*, Festschrift, A. Martin, 1895) of tubal pregnancy six years after vaginal hysterectomy, which at the end of the first eight weeks had vaginal hemorrhage; and Vautrin's case of tubal

pregnancy nine years after vaginal hysterectomy by morcellation for a large uterine fibroid (*Rev. med. de l'est*, 1908, xxxviii). Vineberg concludes that the hemorrhage in his case was due to the sigmoid being acted upon by the trophoblast, and comments on the failure of decidual reaction of the uterine mucosa and the external migration of the ovum.

Successful Treatment of Chronic Gonorrhœal Endometritis.—G. KOLISCHER (*Surg., Gyn., and Obst.*, 1908, vi, 527) states that in this two special points are presented, viz., eradication of the gonorrhœal infection and stopping the abnormal discharge. The method advocated was employed in the treatment of 43 cases, in 29 of which the treatment was persisted in until these two results were produced. Kolischer states that a drug, in order to be employed successfully on the endometrium, should be a strong germicide and should produce sufficient reaction to produce an intense shedding of the mucosa, but not sufficient cauterization for the production of an eschar, and that applications must be applied daily over an extended period of time. The routine employed is as follows: Test the uterus as to its reaction toward the introduction of foreign bodies into its cavity, by introducing carefully a sound to the fundus, under proper precautions, and accustom it to such invasion. Swab out the uterine cavity gently with a saturated solution of bicarbonate of sodium. Sometimes a tenaculum or a volsellum is fastened into the anterior lip of the cervix. A swab soaked in a 3 per cent. albargin solution is now introduced into the uterine cavity and allowed to remain five minutes; after its withdrawal a tampon carrying an ichthyol-glycerin solution of equal parts is placed against the portio, to be removed by the patient the next morning and be followed by a hot salt-water douche. A slight bloody discharge, following a few treatments, is a good sign and does not prevent continuation of the treatment. The applications are continued until the discharge ceases and the absence of pus and gonococci is demonstrated. The specimens should be taken after provocatory influences have been active, such as during and after menstruation, twenty-four hours after the patient has taken some charged alcoholic beverages, or twenty-four hours after the mucosa has been touched with a 1 to 1000 bichloride solution. Occasionally the reaction from the albargin is obtainable only after the use of a sharp curette or swabbing with a 40 per cent. solution of formalin.

The Pathology and Operative Treatment of Displacements of the Pelvic Viscera.—W. E. FOTHERGILL (*Jour. Obst. and Gyn., Brit. Emp.*, 1908, xiii, 410) has written at length and dogmatically upon this subject, his recommendations being based upon his conception of the supports of the pelvic viscera as portrayed in his paper in the same journal last January. Fothergill regards classical prolapse of the pelvic viscera (descent of the uterus, appendages with the bladder, urethra, and vagina) as being due to elongation of the perivascular connective tissue in the base of the broad ligaments and extending laterally up to the internal iliac arteries, that such relaxation can never be removed and that, therefore, the surgical treatment is necessarily limited to plastic surgery of the vagina, perineum, and cervix plus ventrofixation. Fothergill believes a part only of this relaxation may occur, resulting in descent of the bladder and anterior vaginal wall, and even the posterior

wall. In such conditions only the lower portion of the supporting mass is affected, the upper part preserving its function; the treatment should be plastic. Again, Fothergill regards retroversion or retroflexion as due to the same character of relaxation occurring in the upper part of the pelvic viscera and recommends, when surgical treatment is needed, Alexander's operation when the uterus is movable and, if there are adhesions or diseased appendages, laparotomy with appropriate treatment of such complications and Webster's round-ligament operation. Apparently no instances of striking elongation of the uterus with recurrence of prolapse have been noted by him.

Treatment of Gonorrhœa in the Female.—H. WELLAND HOWARD (*Jour. Amer. Med. Assoc.*, 1908, l, 2136) relates a case treated by him in which, after application of 1 per cent. solution of nitrate of silver to the external urinary meatus, the cervix uteri and vaginal walls on alternate days, and later inoculating the vagina with the Doederlien bacillus, the gonococcus was found absent. At the beginning of Howard's treatment the tubes and ovaries seemed to be uninvolved; the cervix was red and not eroded, and near it was a dram of pus containing large numbers of gonococci or pus even when pressure was applied along the urethra.

Primary Cancer of the Fallopian Tube.—LABUSQUIÈRE (*An. de gyn. et d'obst.*, 1908, v, 361) carefully considers primary cancer of the Fallopian tube and states that its diagnosis from pyosalpinx is practically impossible. Labusquière states it is the most malignant and most infrequent form of cancer of the female genitals, and that extension is along the sacral and the inguinal glands; that the Sanger-Barthe theory that it always has an inflammatory basis is untenable; that such phlegmasic changes as salpingitis, occlusion of the abdominal ostium, peritonitic adhesions and tuboövarian cysts can precede, but can also result from, cancer of the tube, and that the histological classification of papillary and papillo-alveolar cancer must be modified in the sense that papillary cancer represents the initial stage and the alveolar the ulterior stage of the papillary form.

Arteriosclerosis of the Uterus.—R. B. SLOCUM (*Surg., Gyn., and Obst.*, 1908, vi, 352) reports a case of this condition and reviews the literature of the subject. Following Solowij, Slocum divides the cases clinically into two classes. In the first the hemorrhages are into the uterus, forming infarcts and usually accompanying a like condition in other vessels, the splenic artery being a common one; in the second class the hemorrhage occurs from the endometrium. The latter class is more readily recognized and treated. The first class is of interest principally to the pathologist. The second class occurs usually after the menopause, and the safest treatment seems to be hysterectomy.

DISEASES OF THE LARYNX AND CONTIGUOUS STRUCTURES.

UNDER THE CHARGE OF

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Angioma of the Face, Mouth, Tonsil, and Rhino-epiglottic Fold.—NAVRATIL (*Arch. inter. de laryng., d'otol., et de rhin.*, March-April, 1908) reports a case. An operation was attempted, but on anesthetizing the patient there was such an afflux of blood to the angioma during the period of excitation that symptoms of dyspnœa appeared, rendering immediate tracheotomy necessary. It was hence inferred that preliminary tracheotomy should always be performed in similar cases.

The Curing of Catarrhal Deafness by Cleaning Out the Fossæ of Rosenmueller.—JERVEY (*Jour. Amer. Med. Assoc.*, May, 16, 1908) contends that many cases of cartarrhal deafness and tinnitus aurium are due to impaired motility of the pharyngeal extremity of the Eustachian tubes, the result of granulation tissue or of hypertrophied lymphoid tissue in the fossæ of Rosenmüller, or to restriction by bands of tissue in sequence of the previous inflammatory conditions. These being scooped away with the forefinger passed behind the palate, hearing improves at once or within a few hours. To prevent recurrence the raw surfaces are mopped with a solution of silver nitrate or of argyrol every forty-eight hours for from ten days to two weeks.

Rhinœdema with Polyp Formation.—HITSCHLER (*Penna. Med. Jour.*, August, 1908) reports a case of his own and three other cases. No organic disease was present in any of these five cases. Their most marked features, as of others not referred to, were the absence of inflammatory reaction and the recurrent nasal œdema, whether simple œdema or as a polyp.

Orbital Abscess Secondary to Nasal Disease.—REBER (*Penna. Med. Jour.*, August, 1908) reports two cases, one the result of acute purulent sinusitis and the other a sequence to purulent rhinitis which had been set up by the presence of a foreign body—a swollen white bean—occluding the left nasal fossa.

Four Frontal Sinuses.—MARTIN COHEN (*Jour. Amer. Med. Assoc.*, June 6, 1908) reports a skull which otherwise presented no unusual anatomical features, in which there were present on each side of the frontal septum two sinuses, one posterior to the other, and each having a distinct and separate nasal frontal duct which drained into the middle meatus of the nose. A complete bony septum separated the sinuses on each side.

Operations on the Frontal Sinus.—Beck (*Jour. Amer. Med. Assoc.*, August 8, 1908) describes in detail and illustrates a new method of exposing and operating upon the frontal sinus without deformity. The main feature consists in raising an osteoplastic flap, after bearing the skull by means of an incision through the skin and connective tissue along the upper margins of the eyebrows, then downward a short way upon the nose, and then across the bridge. This skin and subcutaneous flap is then dissected upward as far as required and as had been determined by radiogram beforehand. After the operation the osteoplastic flap is replaced and the skin flap brought down and sutured with silkworm gut.

Sarcoma of the Septum and Rhinopharynx.—Williams (*Jour. Laryn.*, July, 1908) reports the case of an unmarried woman, aged twenty-five years, who had been admitted to the Bristol Royal Infirmary for nasal obstruction and severe and recurring epistaxis after the attempted removal of a supposed nasal polyp. Access to the growth was made by raising an osteoplastic flap, and then nearly the whole septum was removed up to the anterior margin of the cartilage, the left ethmoidal cells and middle turbinal were likewise cleared away back to the sphenoid sinus, and the growth itself was also cleared away from the roof of the rhinopharynx. The osteoplastic flap was finally pushed back into position and sutured. Recovery was uninterrupted without any facial defect or deformity whatever. There had been no recurrence at the end of six months.

Streptococcic Infections of the Pharyngeal Adenoid Tissue in Adults.—From ten cases occurring in her own private practice, Dr. Alice G. Bryant (*Jour. Amer. Med. Assoc.*, June 13, 1908) calls attention to streptococcic infections of the pharyngeal adenoid tissue in cases with symptoms similar to those occurring in pulmonary tuberculosis, malaria, typhoid fever, or influenza. In the discussion of this paper Dr. Shurly stated that the serious sequels and complications of the infectious diseases, such as influenza, typhoid fever, diphtheria, scarlet fever, measles, tonsillitis, arthritis, and others, are in direct proportion to the absorption of toxin from the rhinopharynx—a pathological and therapeutic principle not sufficiently recognized by the average general practiitoner.

Œsophagoscopy in a Sword Swallower.—Hald (*Arch. inter. de laryng., d'otol., et de rhin.*, March-April, 1908) reports his observations in œsophagoscopy upon a sword swallower. The œsophagus had been very largely distended in consequence of the professional feats, and the cricoidean zone of the pharynx was patent and much larger than normal. There was an excoriation upon the posterior wall of the cricoid cartilage. Curiously, the patient could not support the examination any better than ordinary subjects, his œsophagus seeming to have become habituated to flat foreign bodies, but not to cylindrical ones. The mucous membrane was of a deep violaceous red, the result of chronic inflammatory condition, likewise the result of his sword swallowing. The tube could be introduced 45 cm. without reaching the cardia.

Foreign Body in the Left Bronchus Discharged in a Mass of Pus on Bronchoscopic Examination.—C. COMPAIRED (*Arch. inter. de laryng., d'otol., et de rhin.*, May-June, 1908) reports a case of foreign body—a scale of a pine cone—in the left bronchus of a child, aged seven years, which had been in position for more than twelve months, and had produced an extensive purulent bronchopulmonary abscess. The extent of the abscess was revealed by radioscopy, but the foreign body was located. Bronchoscopic examination under chloroform lead to a continuous drainage of the abscess, in the last mass of which the pine scale was embedded and expelled on withdrawal of the instrument, after which the patient made a rapid recovery.

Thymectomy and Thyroidectomy in a Child, Aged Twenty-three Days.—SCHWINN (*Jour. Amer. Med. Assoc.*, June 20, 1908) reports a case of enlarged thymus gland revealed by radiography, which was associated with an enlargement of the left lobe of the thyroid gland. The thymus gland was removed after splitting the sternum, a small piece of the left lobe being left in position for physiological purposes. The enlarged lobe of the thyroid gland was then resected in such a way as to save the parathyroid glands and recurrent laryngeal nerve. The patient made an excellent recovery and had gained three pounds in weight at the time of the report.

PATHOLOGY AND BACTERIOLOGY.

UNDER THE CHARGE OF

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Protective Inoculation against Plague.—R. P. STRONG (*Jour. Med. Research*, 1908, xviii, 325) reports at length upon the various methods of immunization which have been proposed against plague and upon the relative merits of these different measures: the inoculation of killed cultures, of living attenuated cultures, of filtered cultures, and extracts of artificial and of natural plague aggressines, and of inoculation according to Klein's method. The comparison of different methods seems to indicate that, while it is obvious, for several reasons, that for immunization in man in general the inoculation of killed cultures or extracts is far preferable and safer than the method of bacterial vaccination, nevertheless it would appear that in plague only by vaccination, with attenuated culture, can a satisfactory immunity be obtained. The usual adult dose is one twenty-four-hour agar slant culture, and children one-half to one-third of this amount of a strained culture designated "pest avirulent." Even in using these large amounts no severe reactions have been found. Usually, in a few hours after the vaccination, the temperature rises a little and declines on the following days to normal.

Sometimes there is a moderate leukocytosis. The deep, intramuscular injections are followed by induration which gradually subsides in a couple of days; no visible suppuration has ever occurred. The tissues when examined in animals showed that the organisms were still numerous after from six to eight hours, but in twenty-four hours none could be cultivated from the tissues. The process of immunization, then, was similar to that in a true vaccination, the organism reproducing itself in the tissues for some generations, then successive groups of receptors stimulating the production of corresponding groups of amboceptors in the animal body. In the vaccination of a large number of human beings, owing to individual variations in susceptibility to plague infection, all will certainly not be protected against the lethal infection by a single vaccination, but certainly a good proportion will be partially immunized and the immunity may last for some months. Therefore, it may frequently be necessary, as in smallpox vaccinations, to repeat and even use larger doses if necessary. It appears that the attenuated cultures, when carefully watched and tested, are of little danger in the vaccination of human beings. Nevertheless the work must be carefully carried out in many different races and classes of people before it can be adopted for general use. However, as the other measures have proved somewhat inadequate in the suppression of plague, this method of vaccination holds out, in certain endemic centres, greater hope of success in the suppression of this dread disease.

Polycythemia.—LOMMEL (*Deut. Arch. f. klin. Med.*, 1907, xcii, 83) describes a case of polycythemia with moderate enlargement of the spleen. The red blood corpuscles varied between 9,700,000 and 10,200,000. The hemoglobin was 140 per cent., the white blood cells 5300. In smears of the blood, scattered nucleated red blood cells were seen. The viscosity of the blood was much increased and was estimated at 11.2 against a normal of 5. The absorption capacity of the red blood cells for oxygen was tested at room temperature and the co-efficient of absorption was found to be 1.01. Finally the respiratory exchange of gases was investigated by the method of Zuntz-Gleeppert. The mean of the total respiratory volume for three days was 8561 cm. per minute, which is more than that given by Magnus Levy for the upper limit of normal (4500 to 7000 cm.) The average output of CO_2 pro kilo per minute was 3.23, and the intake of oxygen 4.42. These figures, again, stand at the very upper limit of normal. Lommel also made estimations of the total amount of urobilin which was excreted in the urine and feces, to see whether, with the polycythemia, there was a decreased destruction of red blood corpuscles. In this case the total amount of urobilin eliminated in one day was 325 mg., a very large quantity. Since it was impossible to establish any cause for the polycythemia, such as disease of the heart or lungs, Lommel thinks that the condition was dependent upon a decrease in the capacity of the red cells for the absorption of oxygen.

Immunity in Rocky Mountain Spotted Fever.—A few years ago it was shown by Ricketts that the spotted fever, so common in the Bitter Root Valley of Montana, could be transmitted to guinea-pigs

and monkeys by intraperitoneal inoculation of citrated blood from subjects ill with the disease. During the experiments it was noted that one attack of spotted fever renders monkeys immune to a second inoculation. RICKETTS and GOMEZ (*Jour. Infec. Dis.*, 1908, v, 221) now find that there is no authoritative example of two attacks of the disease in the same person in the region of the Bitter Root Valley, and their inoculation experiments on guinea-pigs and monkeys go to show that one attack of the disease confers a strong, active immunity. This immunity in animals is characterized by the presence of immune bodies in the serum, which are sufficient to neutralize an active virus, when virus and immune serum are inoculated together; or which will establish a passive immunity in healthy guinea-pigs. The blood or blood serum of an immunized guinea-pig also has slight curative power, and when injected during the first few days of disease will modify the severity of the infection or when given two or three days after injection of virus, will protect the animal against the disease. By the method of mixed immunization, in which virus and immune serum are given together, guinea-pigs may be made to acquire an active immunity against subsequent inoculation. Since it has been shown that the horse is susceptible to the disease, Ricketts and Gomez hold out the hope that a serum may be obtained which may be used for protective inoculation in man. In order that this serum may be efficacious it would have to be injected within a day or two following the bite of the tick, which insect they have already found transmits the disease to man.

The Excretion of Hexamethylenamin (Urotropin) in the Bile and Pancreatic Juice.—It has been known for some time that certain substances, such as potassium iodide, pass more or less readily into the bile, and at least one substance, potassium iodide, has been shown definitely to be excreted by the pancreatic juice. CROWE (*Johns Hopkins Hosp. Bull.*, 1908, xix, 109) has experimented with the excretion of urotropin, a substance, which on account of its disinfecting properties, might be of great value in destroying certain bacteria infecting the gall-bladder, and finds that when urotropin is given by the mouth it passes very quickly into the bile. Hexamethylenamin or its decomposition product formalin, is excreted directly by the wall of the gall-bladder as well as by the liver cells, for after ligation of the cystic duct in dogs, the substances could be found in the bile of the isolated gall-bladder as well as in the bile coming from the common duct. Following administration by mouth, the drug was rapidly absorbed in the dog and could be demonstrated in the circulating blood when it remains for twenty-four hours. It was found further, that the drug was secreted in the pancreatic juice of dogs and after intraveous administration of 1 gram appeared in the saliva and milk. The practical value of the experiments was borne out by the study of the affect of administration by mouth of urotropin upon infections of the gall-bladder in man. Urotropin was given to three patients with biliary fistula. In one of these the infecting organism was the colon bacillus. In the first case five doses of 15 grams each, or a total of 75 grains of urotropin, caused the bile to become sterile in twenty-four hours; in the second case after the administration of the same dose, the numbers of colon bacilli in bile coming from the fistula were greatly reduced; while in the third case the bile was rendered

sterile after nine days' treatment. In 2 other cases it could be demonstrated that hexamethylamin is excreted in the spinal fluid and synovial fluid.

Experimental Leukemia in Fowl.—Although leukemia has been described as occurring, not frequently in horses, swine, and dogs, it is comparatively rare in fowl. Attempts have been made by several observers to transmit the disease by various means from one animal to another, but so far all attempts have failed. In this country the disease has been described quite accurately in fowl by WARTHIN (*Jour. Infect. Dis.*, 1907, ix, 360) who, however, made no inoculation experiments. ELLERMANN and BANG (*Zent. f. Bakt.*, 1908, xlii, 595) found among a number of chickens one which showed distinct evidence of leukemia. There was marked anemia with a leukocytosis of 600,000. Of these cells 84 per cent. were large mononuclear lymphocytes. In the normal chicken the average number of leukocytes is about 30,000 and the percentage of large mononuclear cells about 40. The leukemic chicken was killed and an examination of the organs showed a marked similarity to the changes in leukemia as they occur in man. The liver and spleen were swollen and in the capillaries of the liver and the bone-marrow there were characteristic and extensive infiltrations of the large mononuclear cells. Portions of the liver, spleen, and bone-marrow were emulsified in salt solutions and injected intravenously into five healthy chickens. Two of the fowls developed, after two and one-half months, a blood picture resembling that in the case of spontaneous leukemia, and at autopsy the organs showed the same characteristic leukemic infiltrations. A second series of inoculations was made from the organs of one of these chickens into six healthy fowls, all of which developed exactly the same disease. The characteristic changes which typified the disease in all the fowl was the progressive anemia, the marked leukocytosis with relative increase in the large mononuclear cells, and the intravascular leukocytic proliferations in the bone-marrow and liver. The cause of the disease could not be discovered; cultures upon various media, and search for spirochetes and protozoa were made without success. Further experiments seemed to show, however, that the actual presence of the cells was not necessary in order to transmit the disease, for two out of five chickens, inoculated with a clear filtrate of the emulsion of organs, free from cells, developed typical leukemia.

The Adrenals in Arteriosclerosis.—The atheroma which has been observed so uniformly in rabbits, after intravenous injections of adrenalin, has suggested more than once that certain types of arteriosclerosis in man may depend upon some pathological changes in the adrenal glands. Indeed, Josué has described what he terms "hyperepinephrie" a functional hypertrophy, in the adrenals of 3 cases of arteriosclerosis in man. HORNOWSKI and NOWICKI (Virchow's *Archiv*, 1908, cxcii, 338) have, in this connection, studied quite carefully the adrenals from 36 cases of arteriosclerosis and as controls the adrenals from 122 cases which did not show arteriosclerosis. The average weight of the adrenals from the cases of arteriosclerosis did not differ materially from the glands of the control cases. Histological examination of the glands, from the cases of

arteriosclerosis, showed some atrophy of the cells of the cortex with thickening of the capsule and general increase in connective tissue. No changes were noted in the medullary portion of the organs. Hornowski and Nowicki lay little or no stress upon these changes, for they found much the same alteration in many of the adrenal glands from the control cases, and consider that the lesion is secondary to some pathological process in another part of the body. Neither could they determine that the adrenals of rabbits, which had developed atheroma following repeated injections of adrenalin, differed essentially from the glands of normal animals. It may, therefore, be concluded that the adrenals from cases of arteriosclerosis do not show any specific anatomical alterations, and, if the sclerosis is in any way dependent upon alterations in the adrenal gland, it may only be possible to discover these changes by chemical investigations.

The Effect of Pilocarpine on the Output of Lymphocytes through the Thoracic Duct.—Rous (*Jour Exp. Med.*, 1908, x, 329) has been able to confirm some previous investigations concerning a lymphocytosis following intravenous injections of pilocarpine. In the dog he finds that shortly after an injection of pilocarpine the total lymphocytes in the blood are very definitely increased. Intravenous injections of pilocarpine nitrate cause a rapid and considerable increase in the output of lymphocytes from the thoracic duct, and he has determined that this increased supply of lymphocytes accounts for the elevation of the number of lymphocytes in the circulating blood. Among some of the factors which are accessory for producing this large cell output in the lymph are quickened flow and dyspnœic breathing, but he believes that the actual cause is as yet undetermined. It is possible that it is largely dependent upon some mechanical factor, and the explanation which Harvery has suggested, that the increased flow of lymphocytes is due to pressure brought to bear on the lymph nodes and spleen by the contraction of muscle, may be the correct one. Rous, however, could not confirm Harvey's observation that atropine prevents the appearance of a lymphocytosis after pilocarpine injections. These experiments go to show that mechanical factors may be responsible for a rapidly appearing lymphocytosis. They are also important inasmuch as they demonstrate that the contribution of the cells through the thoracic duct may be important in the production of lymphocytosis, and that this lymphocytosis is not dependent upon a direct migration into the blood of cells from the spleen, bone-marrow, and lymph nodes.

The Hemolytic Action of Blood Serum in Malignant Disease.—During the last year Kelling has described a reaction which takes place with the serum of patients suffering with malignant diseases. If small amounts of blood serum from such patients are added to a suspension of red blood cells in salt solution, hemolysis takes place. The red blood cells were derived from several varieties of animals. The blood serum of normal individuals did not bring about hemolysis. Kelling, answering a criticism made by v. Dungern, reported later the results of 600 examinations. Of these cases 265 were suffering from carcinoma and of this number 119 (43.4 per cent.) gave positive hemolytic reactions. Of the 320 cases which were not carcinomatous, a positive reaction was

obtained only in 11 or 3.4 per cent. Crile and Beebe, using human red bood corpuscles instead of red blood cells from animals, have obtained much the same results. Weil has studied the hemolytic action of the blood serum from eight dogs with transplantable lymphosarcoma. He found that the sera of the dogs that had tumors, showed, without exception, a marked hemolytic action toward the red cells of healthy animals of the same species, whereas the red cells from dogs that had tumors were much more resistant. Serum from normal dogs possessed almost no hemolytic action. FISCHEL (*Wien. klin. Woch.*, 1908, xlv, 882) has studied the hemolytic action of the blood serum, after the method of Kelling, in 4 cases of malignant disease and in 7 cases suffering from various other conditions. The serum from one-half the cases of malignant disease, 3 of which were carcinoma, possessed in repeated experiments hemolytic power for the red blood cells of various species of animals, but the reaction did not prove to be specific, for it was obtained in 2 cases of pernicious anemia, 1 of tuberculosis, 1 of chronic heart disease, and 1 of diabetes mellitus.

An Especial Affinity of the Bloodvessels of the Kidney for Adrenalin.—JONESCU (*Wien. klin. Woch.*, 1908, xxi, 513) noted during an experiment upon a rabbit whose kidney was in an oncometer, that very minute doses of adrenalin produced great decrease in the size of the kidney. These experiments were repeated and it was found that doses of adrenalin, which were so small that they produced no more effect upon the general blood pressure than injections of 1 c.c. of salt solution, caused great contraction of the vessels of the kidney, which could be estimated by the shrinkage in the size of the organ. These experiments seemed to show that the bloodvessels of the kidney are peculiarly susceptible to the influence of adrenalin. Indirectly the experiments bear upon the question of the relation between nephritis and the secretion of the adrenal gland. It is possible that a slight hypersecretion of the adrenal may bring about contraction of the vessels of the kidney with deleterious consequences, but without giving rise to an elevation of the general blood pressure.

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